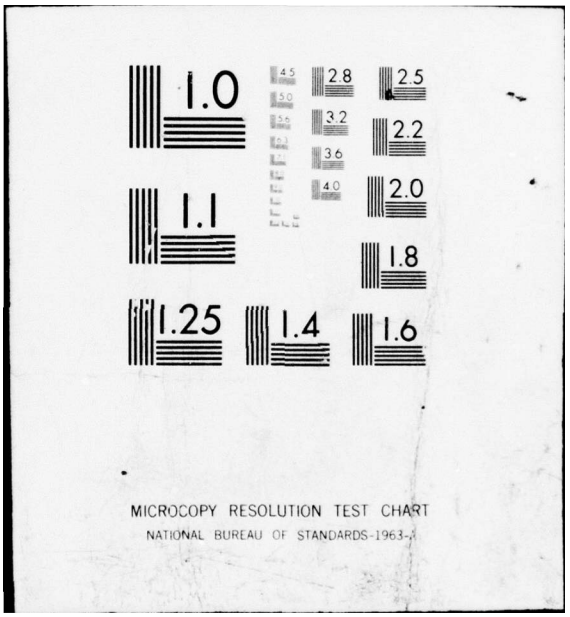
AD-A052 029 BOEING WICHITA CO KS F/G 18/3
STRUCTURAL RESPONSE TO SIMULATED NUCLEAR OVERPRESSURE (STRESNO)--ETC(U)
MAR 77 R P SYRING, W D PIERSON DNA001-76-C-0084
UNCLASSIFIED D3-9788-5-VOL-2 DNA-4278F-2 NL

1 OF 8
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1.0
1.1
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5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD-E300094

DNA 4278F-2

STRUCTURAL RESPONSE TO SIMULATED NUCLEAR OVERPRESSURE (STRESNO): A TEST PROGRAM ESTABLISHING A DATA BASE FOR EVALUATING PRESENT AND FUTURE ANALYTICAL TECHNIQUES

Volume II—Program Data

Boeing Wichita Company
3801 South Oliver
Wichita, Kansas 67210

March 1977

Final Report for Period 3 November 1975—28 February 1977

CONTRACT No. DNA 001-76-C-0084

AD A052029

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Prepared for

Director
DEFENSE NUCLEAR AGENCY
Washington, D. C. 20305

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REPORT DOCUMENTATION PAGE

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3. RECIPIENT'S CATALOG NUMBER	
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17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

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19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Static Test
Shock Load Test
Shock Tube
Nuclear Overpressure
Structural Response Analysis
NOVA-2
Basic Structural Elements
Aircraft Vulnerability

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This document reports on the following: (1) Experimental determination of the ability of 17 basic structural elements to withstand simulated nuclear overpressure loads (utilizing Sandia Corporation's THUNDERPIPE Shock Tube) and uniform static pressure loads; (2) Analytical determination of the ability of these structural elements to withstand nuclear overpressure loads and uniform static pressure loads (utilizing the NOVA-2 computer program developed by Kaman AviDyne for the Air Force Weapons Laboratory, Finite element techniques and classical strength analysis techniques); (3) Identification and evaluation of

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20. ABSTRACT (Continued)

cont.

differences between test results and analysis results; (4) Identification of suggested changes to NOVA-2 to upgrade its capabilities; (5) Analytical determination of the sensitivity of structural response to selected structural properties; and (6) Application of study results to future nuclear hardness assessments.

Conversion Boeing factors for U.S. customary to metric (SI) units of measurement.

To Convert From	To	Multiply By
degree (angle)	radian (rad)	1.745 329 X E -2
foot	meter (m)	3.048 000 X E -1
foot-pound-force	joule (J)	1.355 818
inch	meter (m)	2.540 000 X E -2
kip (1000 lbf)	newton (N)	4.448 222 X E +3
kip/inch^2 (ksi)	kilo pascal (kPa)	6.894 757 X E +3
mil	meter (m)	2.540 000 X E -5
pound-force (lbf avoirupois)	newton (N)	4.448 222
pound-force inch	newton-meter (N·m)	1.129 848 X E -1
pound-force/inch	newton/meter (N/m)	1.751 268 X E +2
pound-force/foot^2	kilo pascal (kPa)	4.788 026 X E -2
pound-force/inch^2	kilo pascal (kPa)	6.894 757
pound-mass (lbm avoirdupois)	kilogram (kg)	4.535 924 X E -1
pound-mass-foot^2 (moment of inertia)	kilogram-meter^2 (kg·m^2)	4.214 011 X E -2
pound-mass/foot^3	kilogram/meter^3 (kg/m^3)	1.601 846 X E +1

ACCESSION for
NTIS White Section
DDC Buff Section
UNANNOUNCED
JUSTIFICATION
BY
DISTRIBUTION/AVAILABILITY CODES
Dist. SPECIAL
A

PREFACE TO VOLUME II

This volume includes detail information about the specimens, analysis and tests that is not found in Volume I. The purpose of this volume is to provide the readers with enough data to conduct an in-depth study of the program results if they should care to do so. Static test pressures/stresses/displacements are tabulated. To avoid expansion of this document into many volumes, only selected time history plots of pressure, stress, strain and displacement data from the shock tests are presented. The information in this volume is compiled and presented for each specimen by specimen number.

The Table of Contents, shown in matrix form on Page 7 , identifies the page number where each piece of desired information can be found.

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1	11	12	13-15	16	17	18	19	20-51
2	53	54	55	56	57	58-60	61	62-82
3	84	85	86-87	88	89	90-91	92	93-117
4	119	120	121	122	123	124-127	128	129-215
5	217	218	219-220	221	222	223	224	225-285
6	287	288	289-290	291	292	293-297	298-299	300-346
7	348	349	350-351	353	363	365	366	369-391
8	348	349	352	354	364	367	368	392-416
9	418-419	420	421-422	426-427	430	432-435	436-437	443-465
10	418-419	420	423-425	428-429	431	438-440	441-442	466-496
11	498	499	500-501	502	503	504-509	510	511-538
12	540-541	542	543-546	549	551	553-559	560	569-603
13	540-541	542	547-548	550	552	561-567	568	604-638
14-17	640	641	642-645	646-654	655	656-657	658	659-699

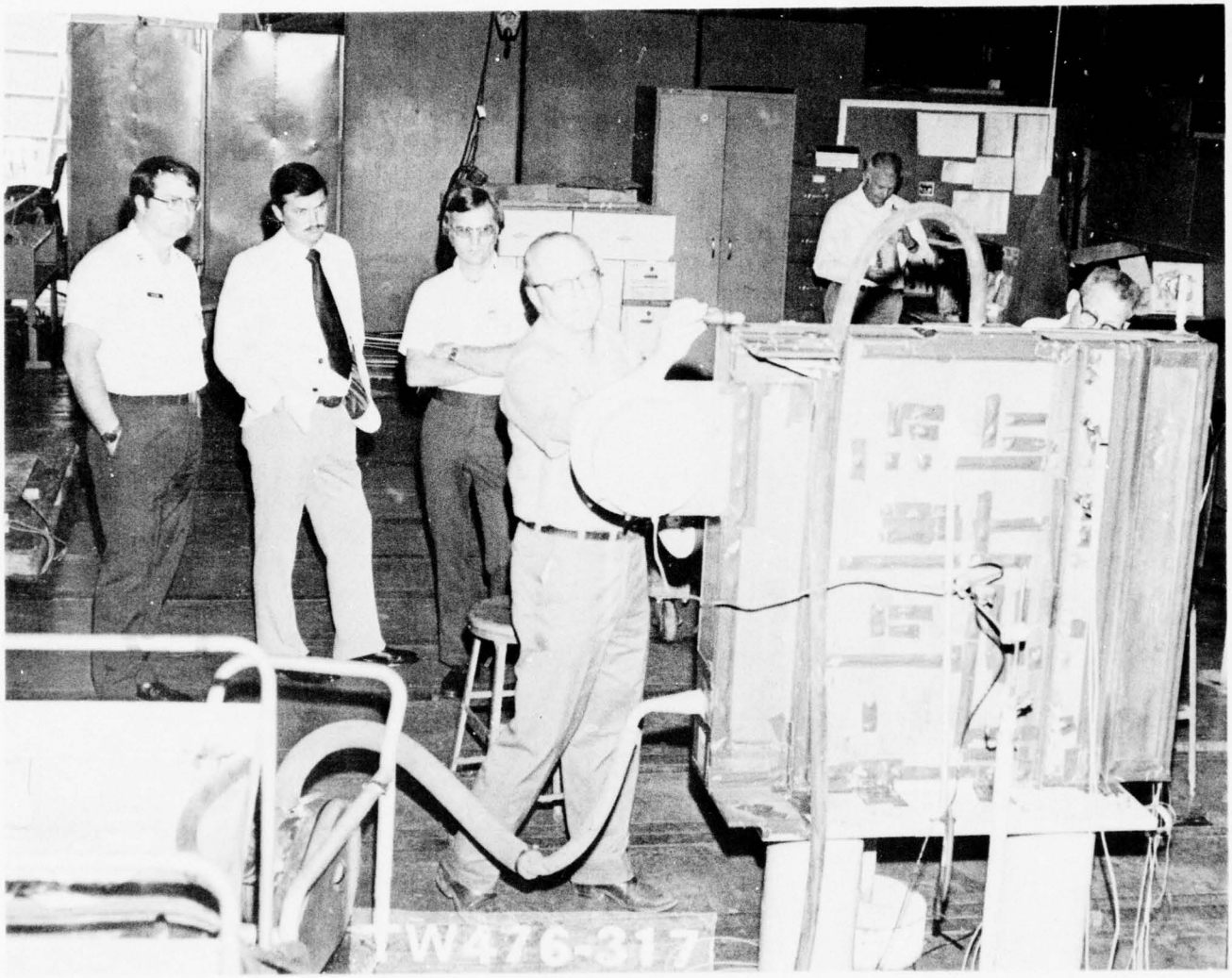


FIGURE 136 - TYPICAL TEST SET-UP - FLAT PANEL FIXTURE

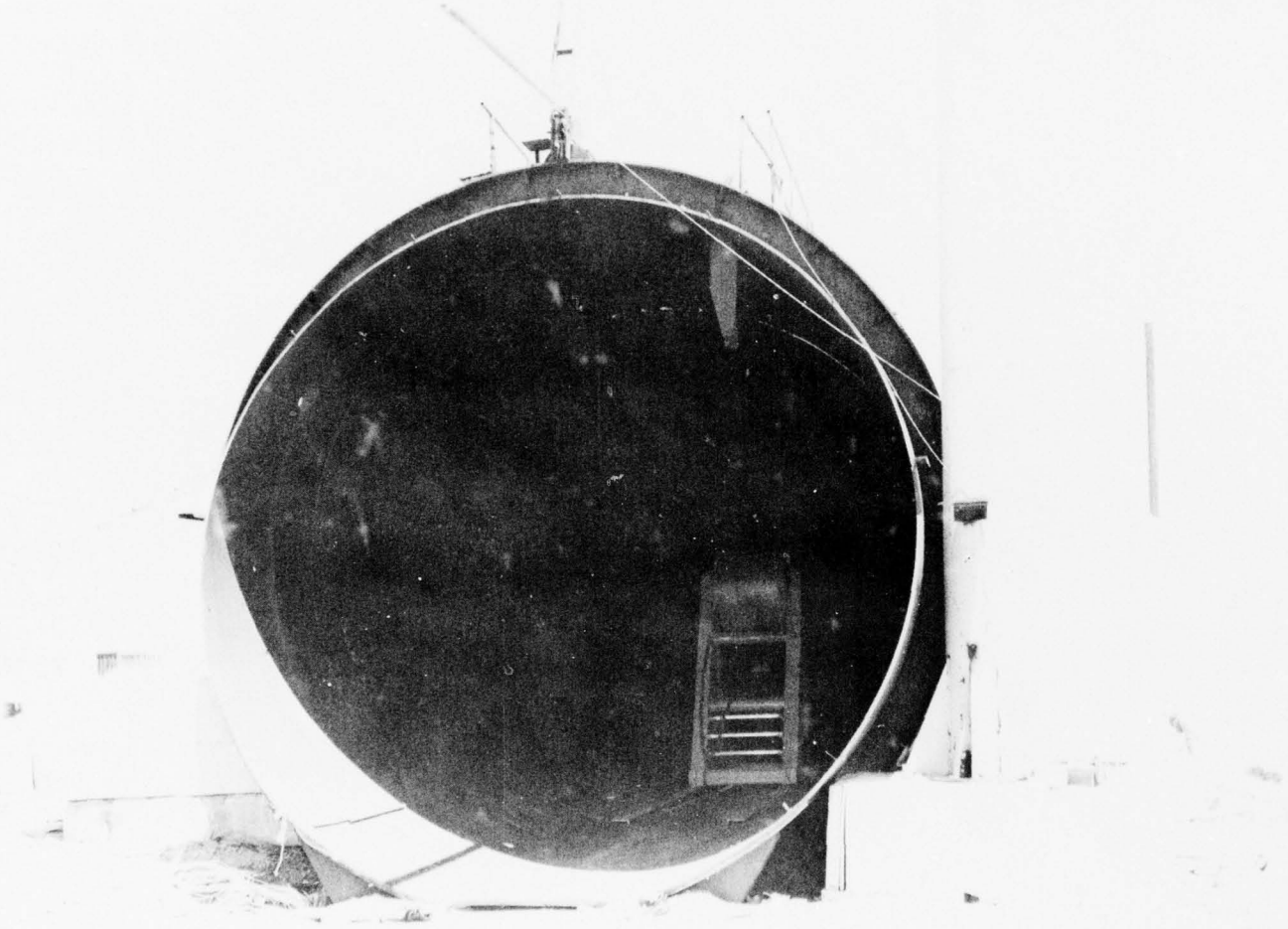
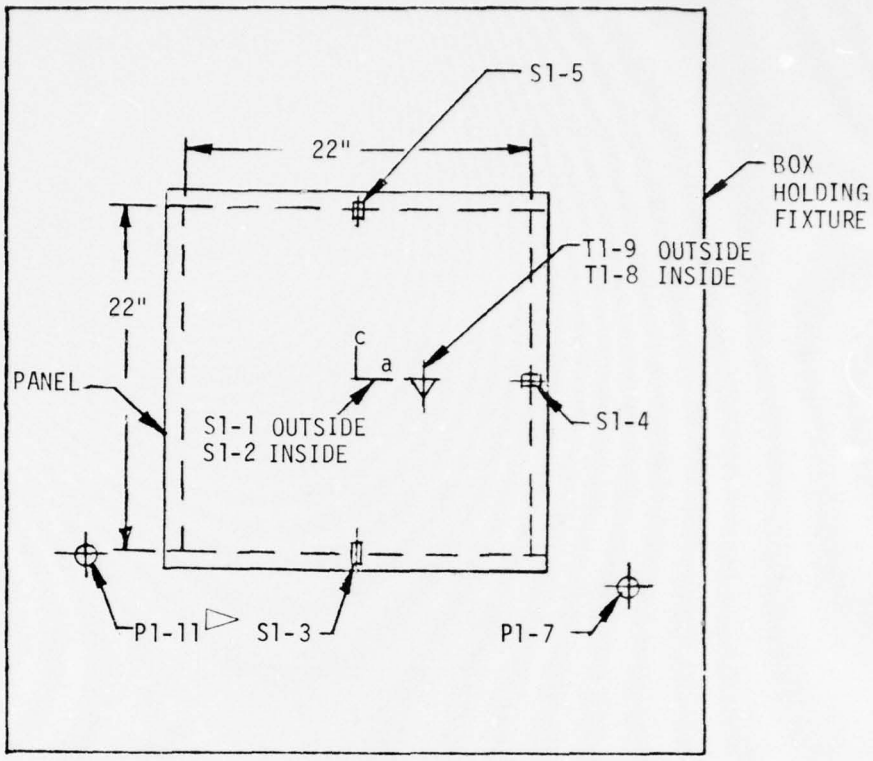


FIGURE 137 - MUZZLE END OF THUNDERPIPE SHOCK TUBE - STRESNO TOWER INSIDE

SPECIMEN DESCRIPTION AND INSTRUMENTATION LOCATIONS



SPECIMEN NO. 1

FLAT UNSTIFFENED PANEL

FOUR SIDES CLAMPED

MATERIAL - 6061-T6 ALUMINUM ALLOY

DENSITY - .0002539 lb-sec^2/in.^{4} (MIL-HDBK-5)

POISSON'S RATIO - .33

MODULUS OF ELASTICITY - 11.0 x 10^6 PSI

SHEAR MODULUS - 3.8 x 10^6 PSI

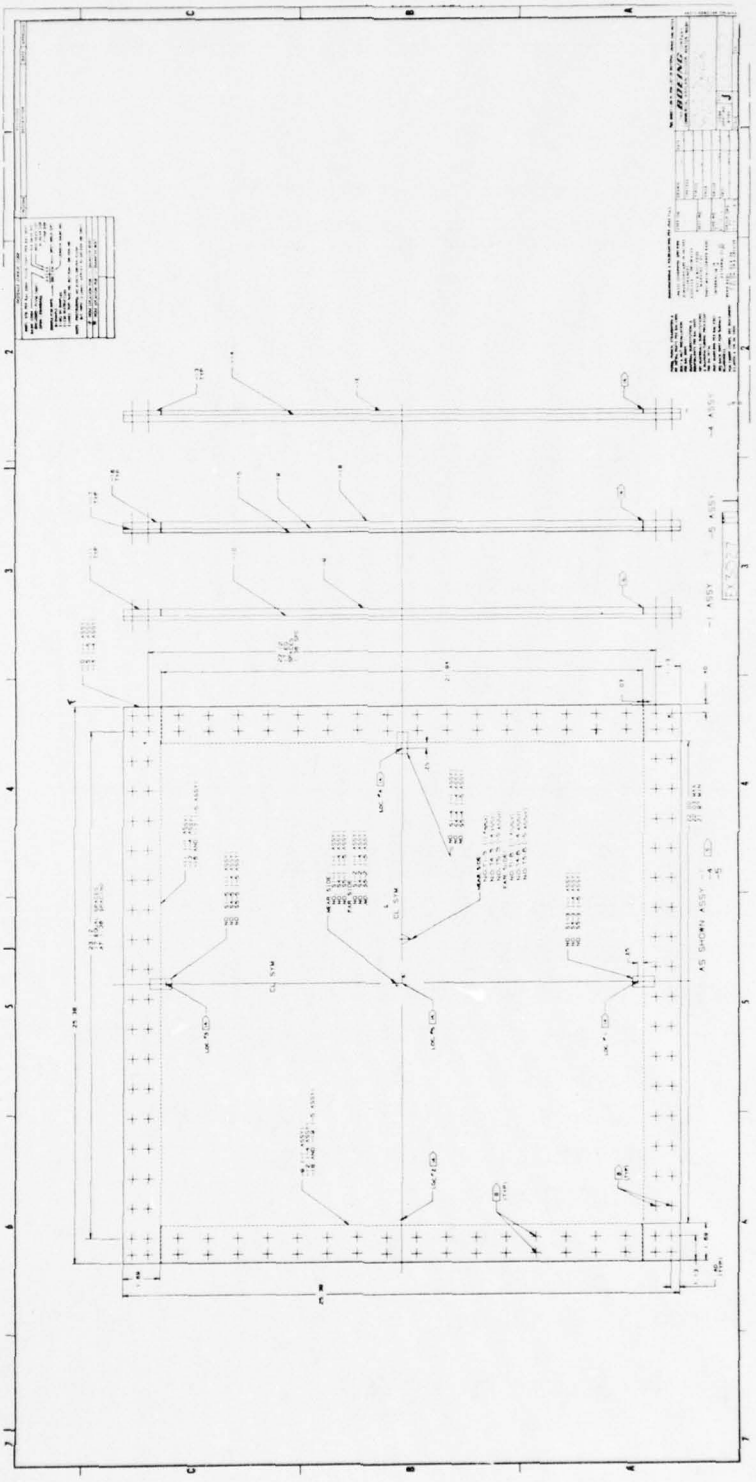
% ELONGATION - 14.5

F_{ty} = 40,350 PSI

F_{tu} = 44,820 PSI

THICKNESS - 0.1915 IN.

▷ ON BACK SIDE ON BOX HOLDING FIXTURE ONLY



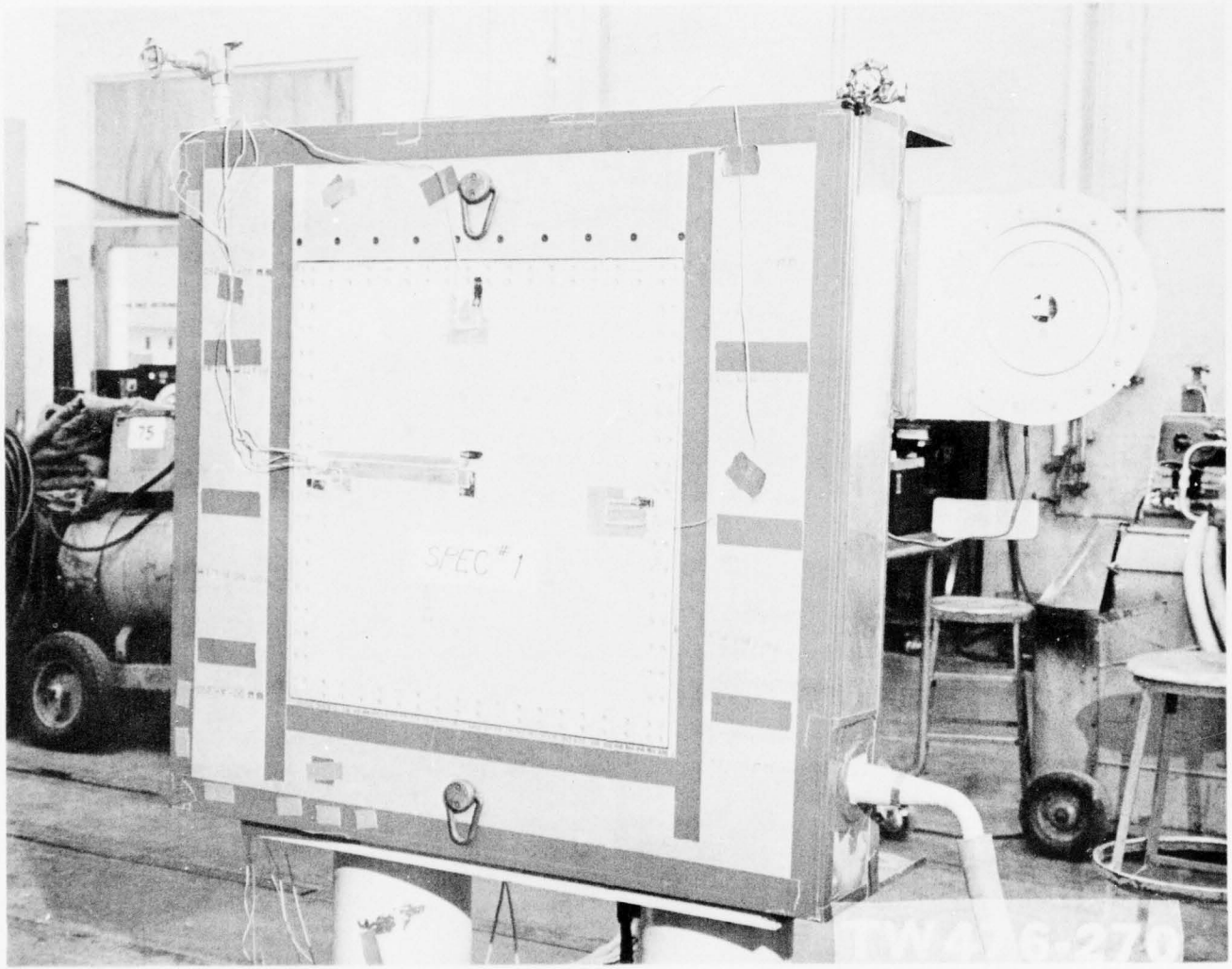


FIGURE 1-1 - SPECIMEN NO. 1 - TEST SET-UP

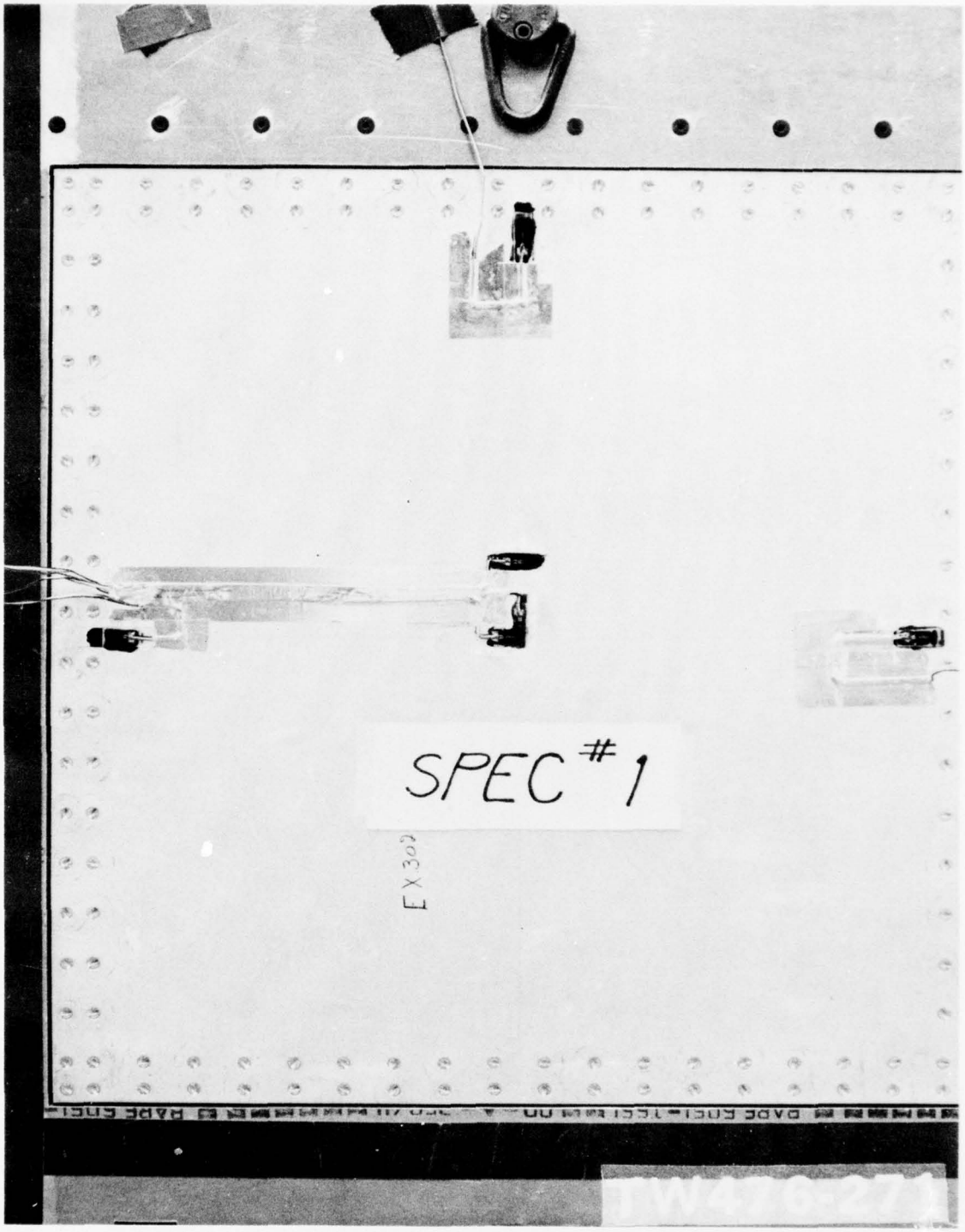


FIGURE 1-2 - SPECIMEN NO. 1 - INSTRUMENTATION - FRONT

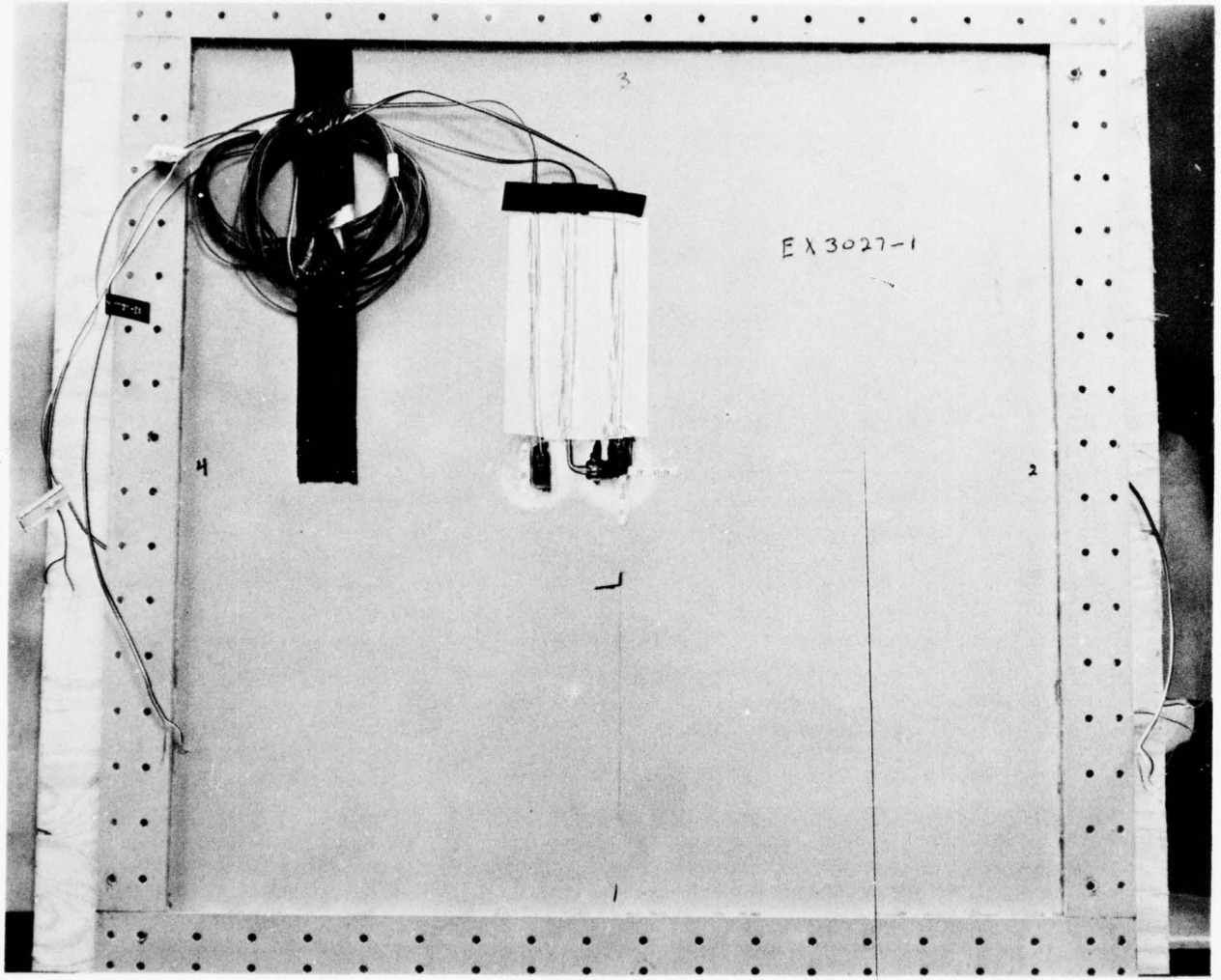


FIGURE 1-3 - SPECIMEN NO. 1 - INSTRUMENTATION - BACK

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.1 - STATIC ANALYSIS - PRESS = 5.0 PSI - MAY'70 - SYRING   GP  1
          1              0                                                 GP  2
0.0        0.1            0.01          0.0                               GP  3
0.0        0.0            0.0           0.0                               GP  4
         15             15                                                 GP  5
100000.                                                                    GP  7
                                                                           GP  8
          2              0                                                 GP  9
          2                                                                GP 10
          0              0                                                 GP 12
          0              0                                                 GP 15
          2              2                                                 GP 18
0.0        0.0                                                             GP 19
0.0        42.0                                                            GP 19
-42.0      0.0                                                             GP 20
-42.0      42.0                                                            GP 20
          0                                                                GP 21
          4              1              1                                 GP 25
-21.0      0.0            21.0                                            GP 26
-5.0                                                                       GP 30
          5              5             11             11                  GPP  1
          0              1              1                                 GPP  2
         10                                                                GPP  3
          2              5                                                 GPP  4
          3              4                                                 GPP  4
          3              5                                                 GPP  4
          4              3                                                 GPP  4
          4              4                                                 GPP  4
          4              5                                                 GPP  4
          5              2                                                 GPP  4
          5              3                                                 GPP  4
          5              4                                                 GPP  4
          5              5                                                 GPP  4
          1                                                                GPP  5
22.0       22.0                                                            GPP  6
0.1915     .0002539                                                        GPP  7
11000000.  11000000.      0.33          0.33          3800000.            GPP  8
40350.     40350.                                                          GPP  9
0.0        0.0            0.0           0.0           0.0           0.0   GPP 13
0.0        0.0            0.0           0.0           0.0           0.0   GPP 13
0.0        0.0            0.0           0.0           0.0           0.0   GPP 13
0.0        0.0            0.0           0.0           0.0           0.0   GPP 13
0.0                                                                        GPP 13
.000001    .000001        1.0                                             GPP 14
                                                                           GP  32
```

TABLE XXI

STATIC TEST STRESSES - SPECIMEN NO. 1
(STRESSES GIVEN IN PSI)

STRAIN GAUGE	STATIC PRESSURE (PSI)				
	2.0	4.0	6.0	7.0	8.0
S1-1	2964.	4750.	5692.	5960.	6207.
S1-2	3707.	6839.	9508.	10665.	11638.
S1-3	7616.	14356.	20553.	23417.	26269.
S1-4	7049.	13258.	18825.	21380.	23837.
S1-5	7142.	13529.	19232.	21985.	24664.

TABLE XXII

STATIC TEST DISPLACEMENTS - SPECIMEN NO. 1
(DISPLACEMENT MEASURED AT CENTER OF PANEL)

	STATIC PRESSURE (PSI)				
	2.0	4.0	6.0	7.0	8.0
DISPLACEMENT (INCHES)	.078	.140	.193	.216	.237

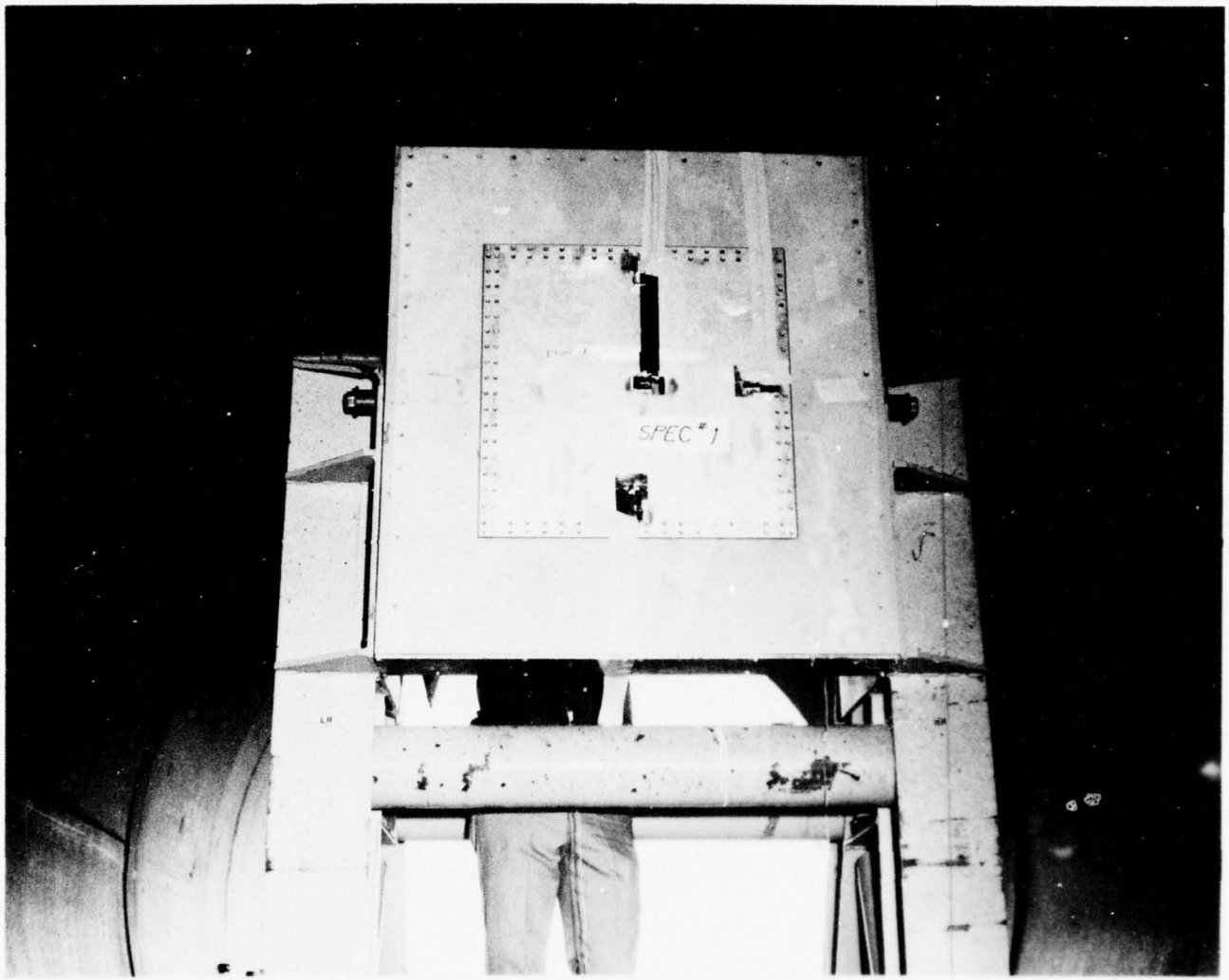


Figure 1-4 - SPECIMEN NO. 1 - SHOCK TEST SET-UP

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.1 -DYNAMIC ANALYSIS - ITERATIVE TPD SOLUTION                    GP  1
          1          0                                                           GP  2
5000.      0.001      0.02       0.0                                            GP  3
0.0        0.0        0.0        0.0                                            GP  4
         15         15                                                          GP  5
500.                                                                            GP  7
                                                                                GP  8
          2          0                                                          GP  9
          0          1                                                          GP 10
0.5                                                                             GP 11
          0          0                                                          GP 12
          0          0                                                          GP 15
          2          2                                                          GP 18
48.0       0.0                                                                  GP 19
20.0       96.0                                                                 GP 19
-60.0      0.0                                                                  GP 20
-70.0      96.0                                                                 GP 20
          0                                                                     GP 21
          4          1          1                                              GP 25
-21.0      0.0        21.0                                                      GP 26
                                                                                GP 30
          5          5         11         11          6                       GPP  1
          0          1          1                                             GPP  2
         10                                                                     GPP  3
          2          5                                                         GPP  4
          3          4                                                         GPP  4
          3          5                                                         GPP  4
          4          3                                                         GPP  4
          4          4                                                         GPP  4
          4          5                                                         GPP  4
          5          2                                                         GPP  4
          5          3                                                         GPP  4
          5          4                                                         GPP  4
          5          5                                                         GPP  4
          1                                                                    GPP  5
22.0       22.0                                                                 GPP  6
0.1915     .0002539                                                             GPP  7
11000000.  11000000.  0.33       0.33       3800000.                          GPP  8
40350.     40350.                                                             GPP  9
0.0        0.0        0.0        0.0        0.0        0.0                    GPP 13
0.0        0.0        0.0        0.0        0.0        0.0                    GPP 13
0.0        0.0        0.0        0.0        0.0        0.0                    GPP 13
0.0        0.0        0.0        0.0        0.0        0.0                    GPP 13
0.0                                                                          GPP 13
0.0        .010       25.0                                                   GPP 14
                                                                                GP 32
```

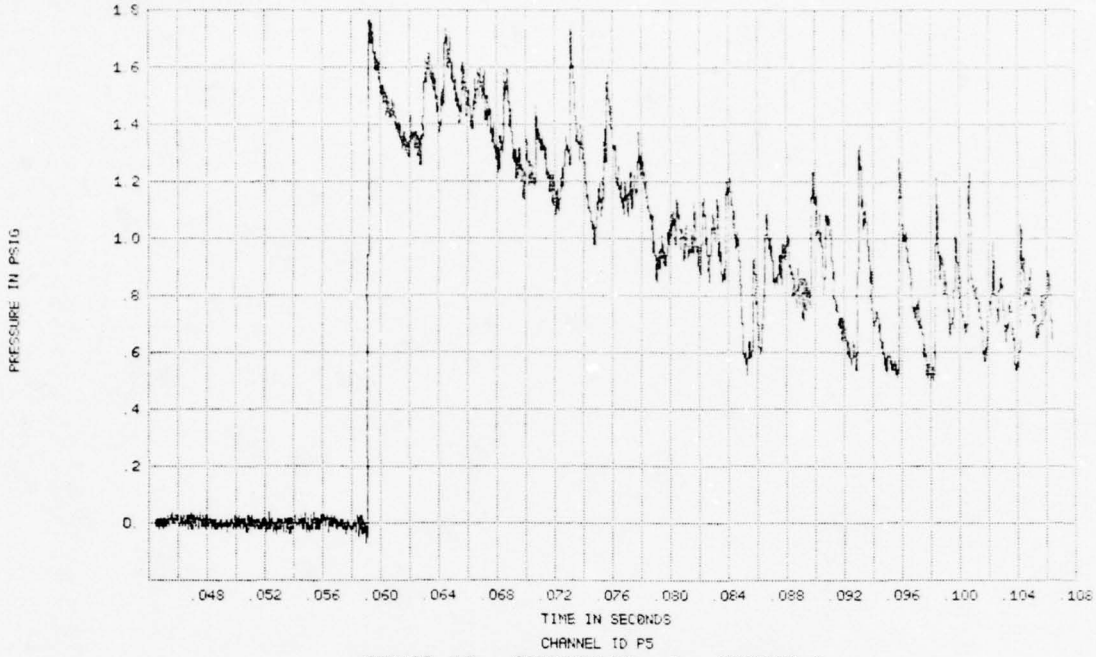


FIGURE 1-5 , SPECIMEN NO. 1 , SHOT NO. 1 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

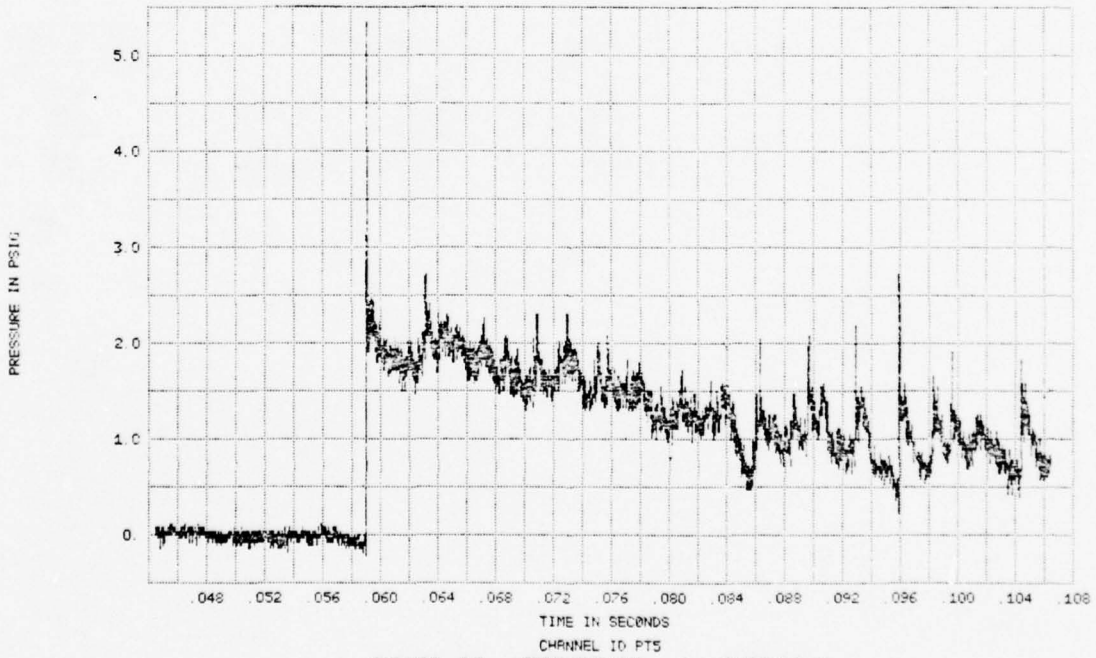


FIGURE 1-6 , SPECIMEN NO. 1 , SHOT NO. 1 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

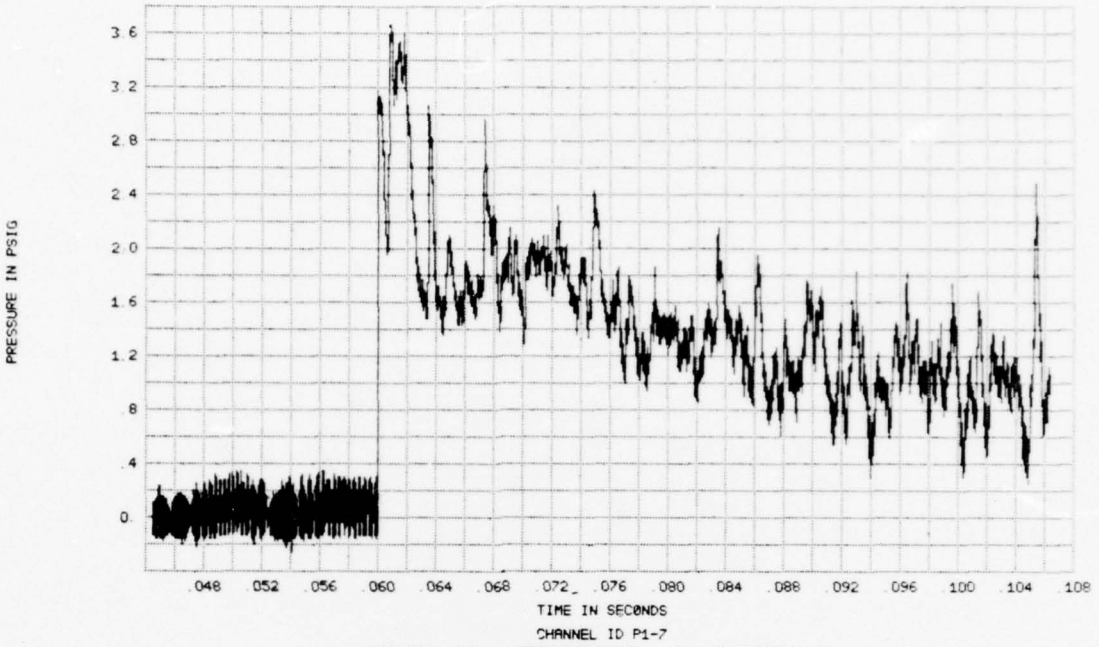


FIGURE 1-7 SPECIMEN NO. 1 , SHOT NO. 1
SPECIMEN REFLECTED PRESSURE TIME HISTORY

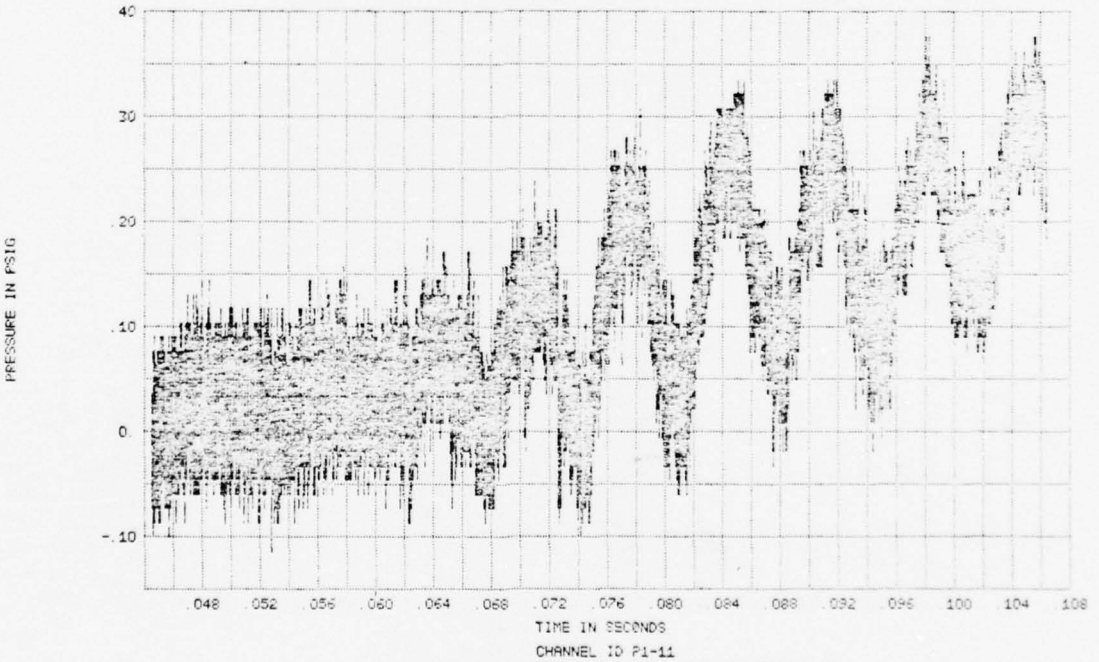


FIGURE 1-8 SPECIMEN NO. 1 , SHOT NO. 1
INTERNAL PRESSURE TIME HISTORY

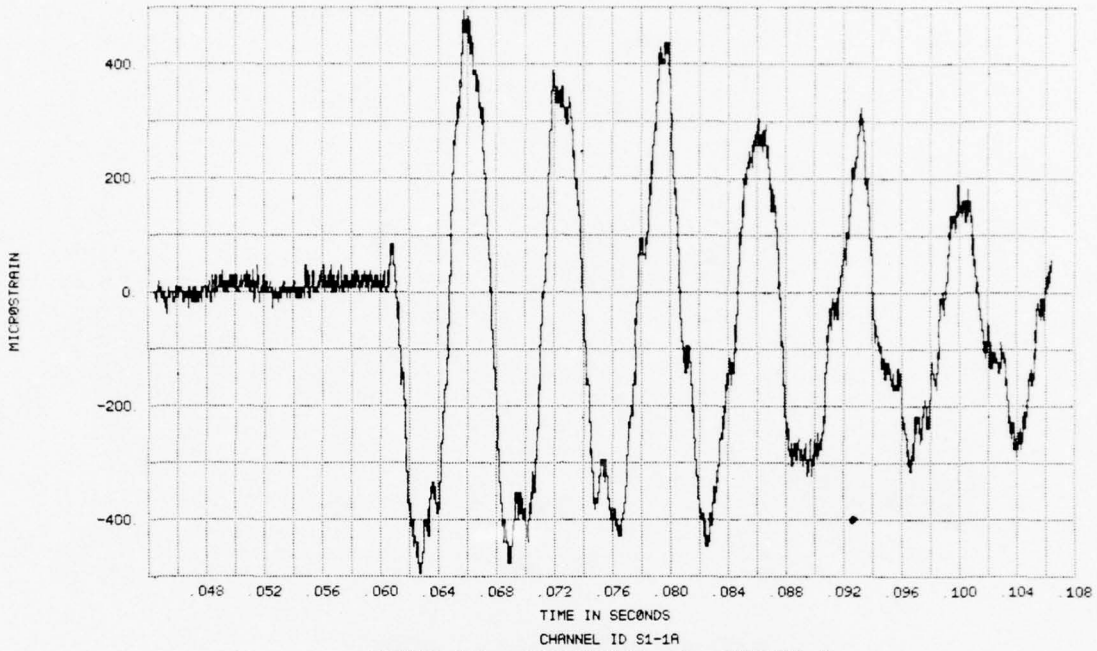


FIGURE 1-9 , SPECIMEN NO. 1 , SHOT NO. 1
STRAIN TIME HISTORY

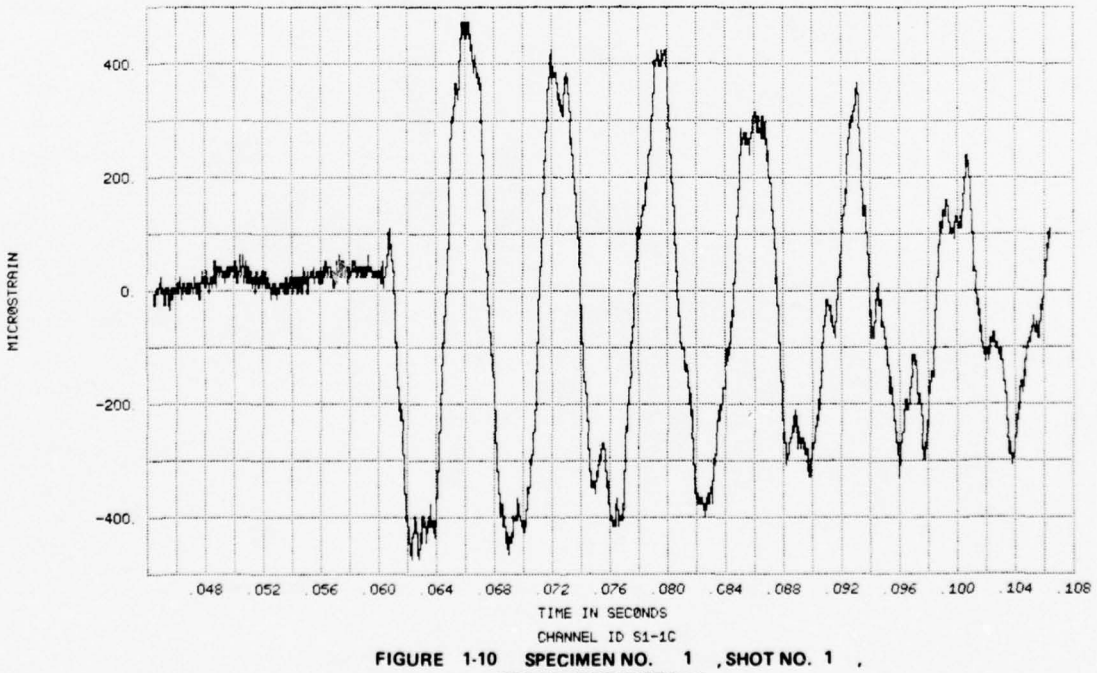


FIGURE 1-10 SPECIMEN NO. 1 , SHOT NO. 1 ,
STRAIN TIME HISTORY

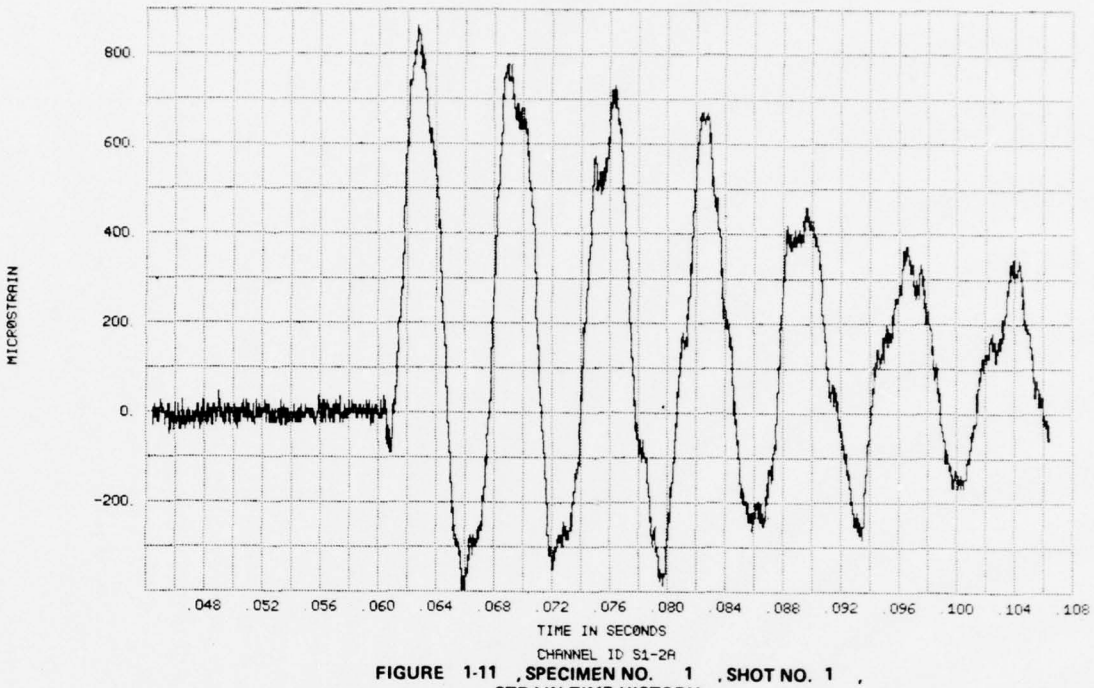


FIGURE 1-11 , SPECIMEN NO. 1 , SHOT NO. 1 , STRAIN TIME HISTORY

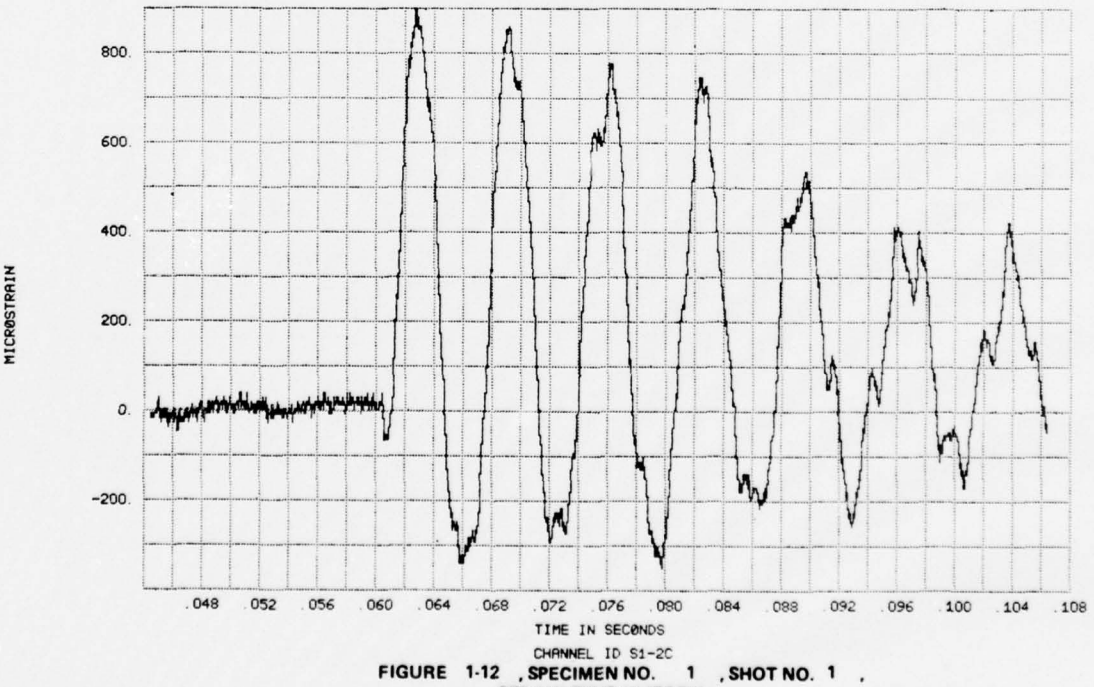


FIGURE 1-12 , SPECIMEN NO. 1 , SHOT NO. 1 , STRAIN TIME HISTORY

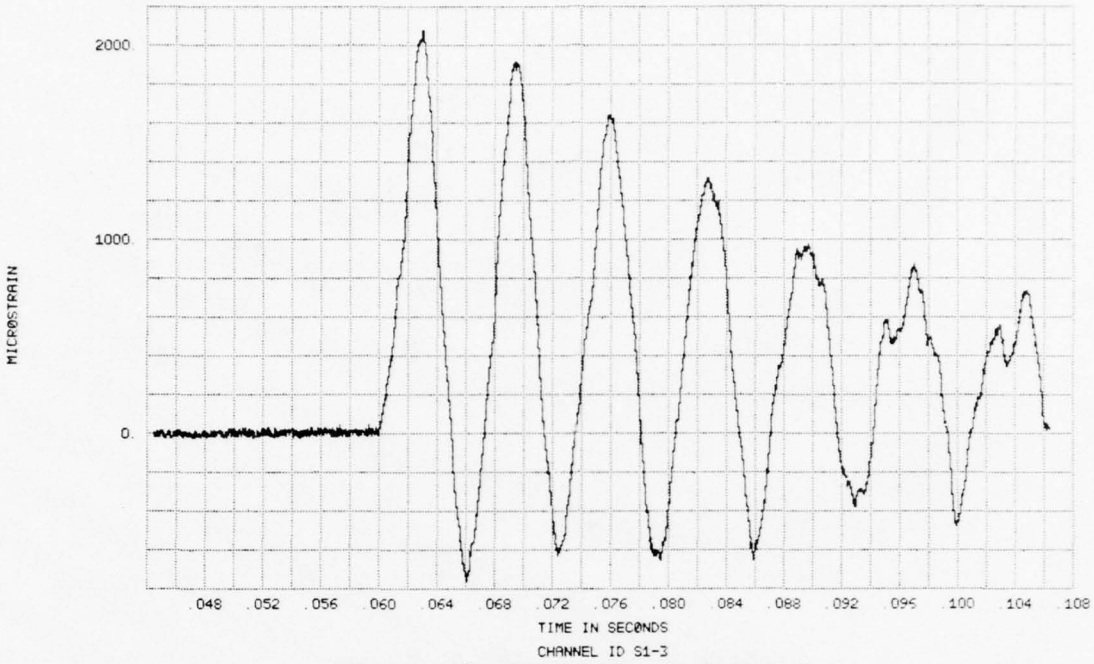


FIGURE 1-13 , SPECIMEN NO. 1 , SHOT NO. 1 ,
STRAIN TIME HISTORY

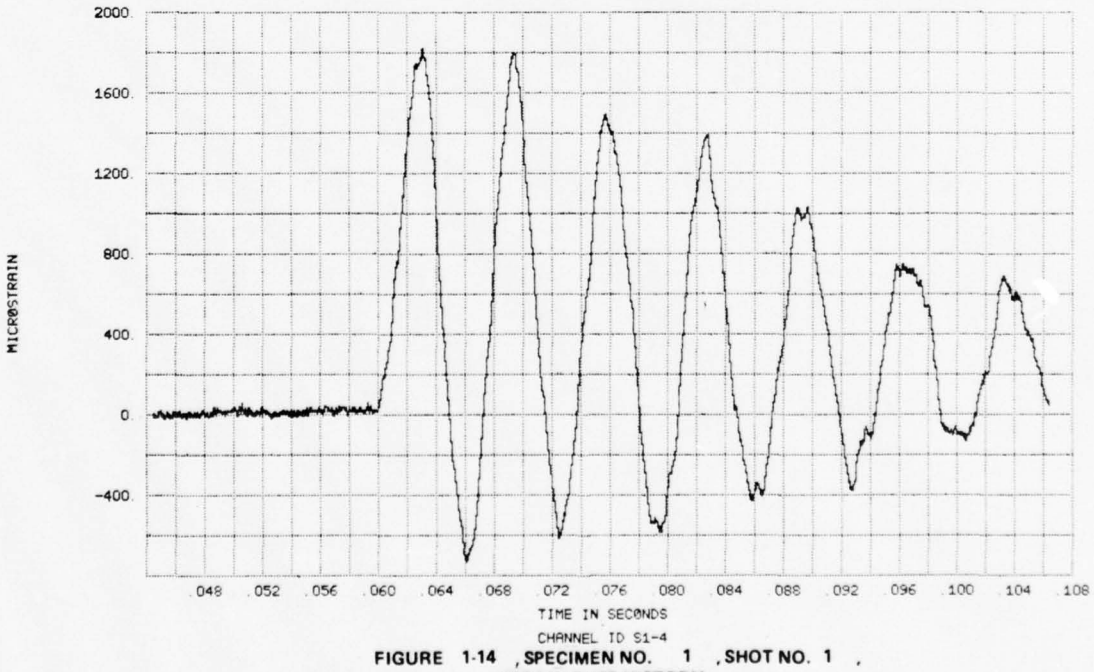


FIGURE 1-14 , SPECIMEN NO. 1 , SHOT NO. 1 ,
STRAIN TIME HISTORY

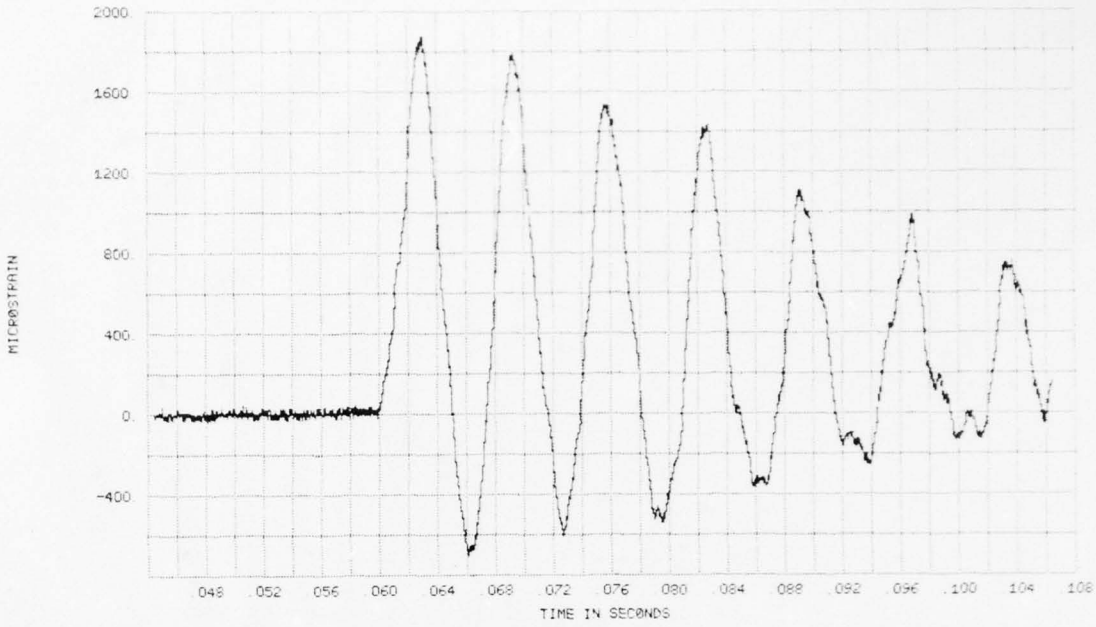


FIGURE 1-15 , SPECIMEN NO. 1 , SHOT NO. 1 ,
STRAIN TIME HISTORY

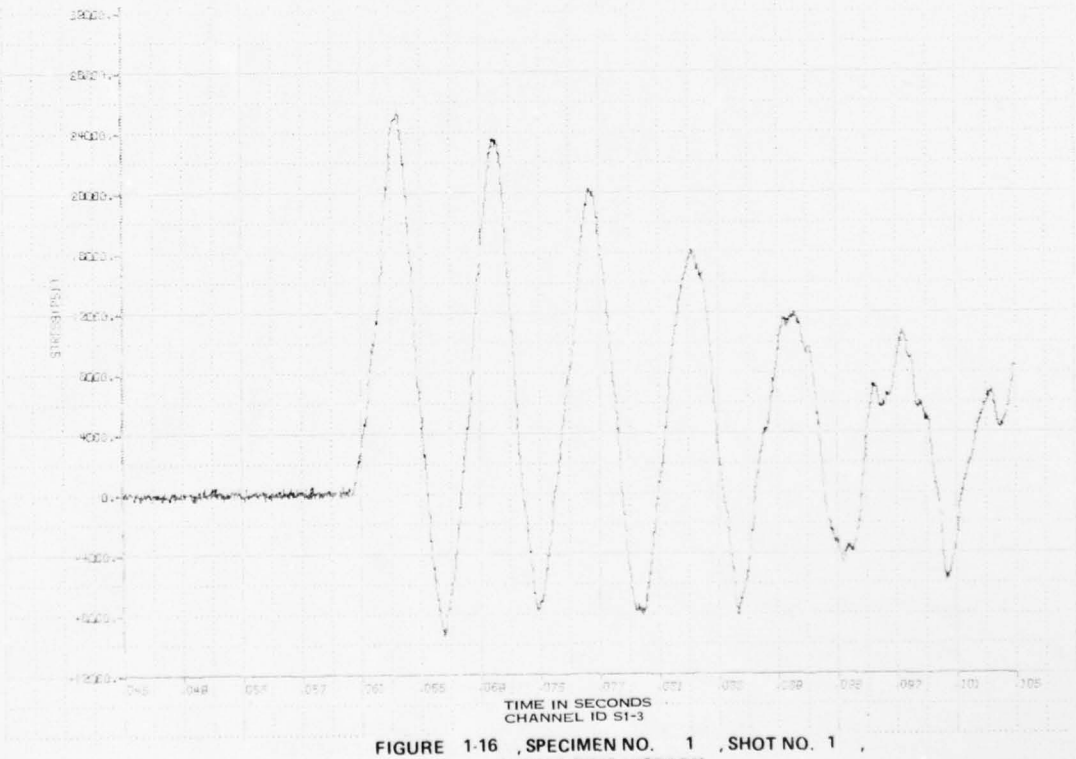


FIGURE 1-16 , SPECIMEN NO. 1 , SHOT NO. 1 ,
STRESS TIME HISTORY

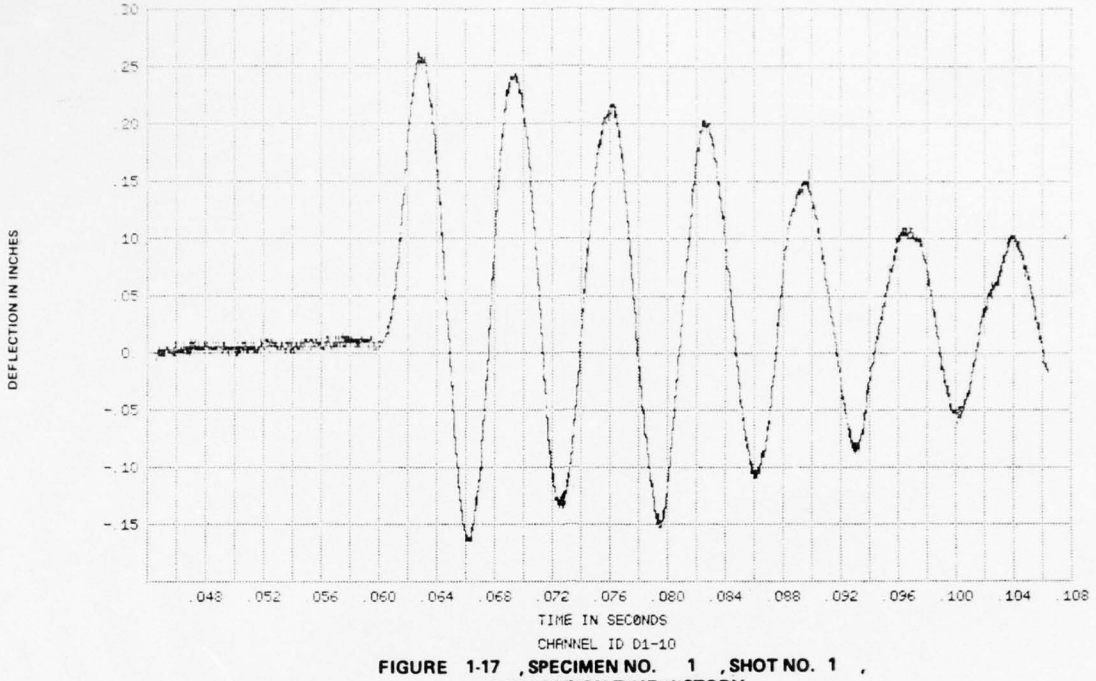


FIGURE 1-17 , SPECIMEN NO. 1 , SHOT NO. 1 ,
DEFLECTION TIME HISTORY

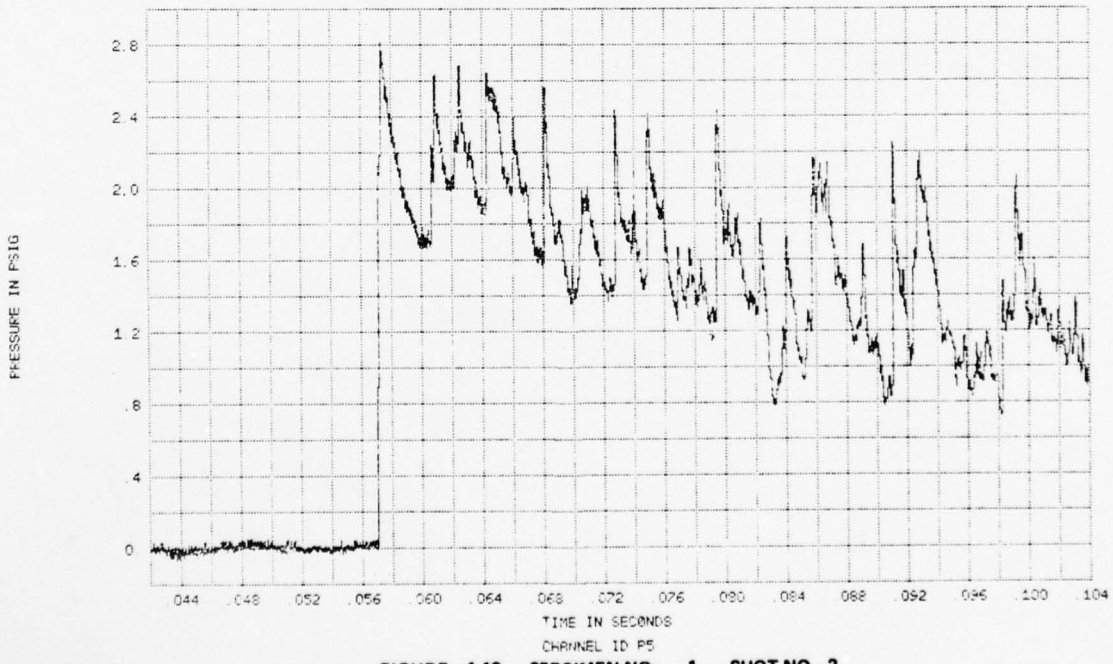


FIGURE 1-18 , SPECIMEN NO. 1 , SHOT NO. 2 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

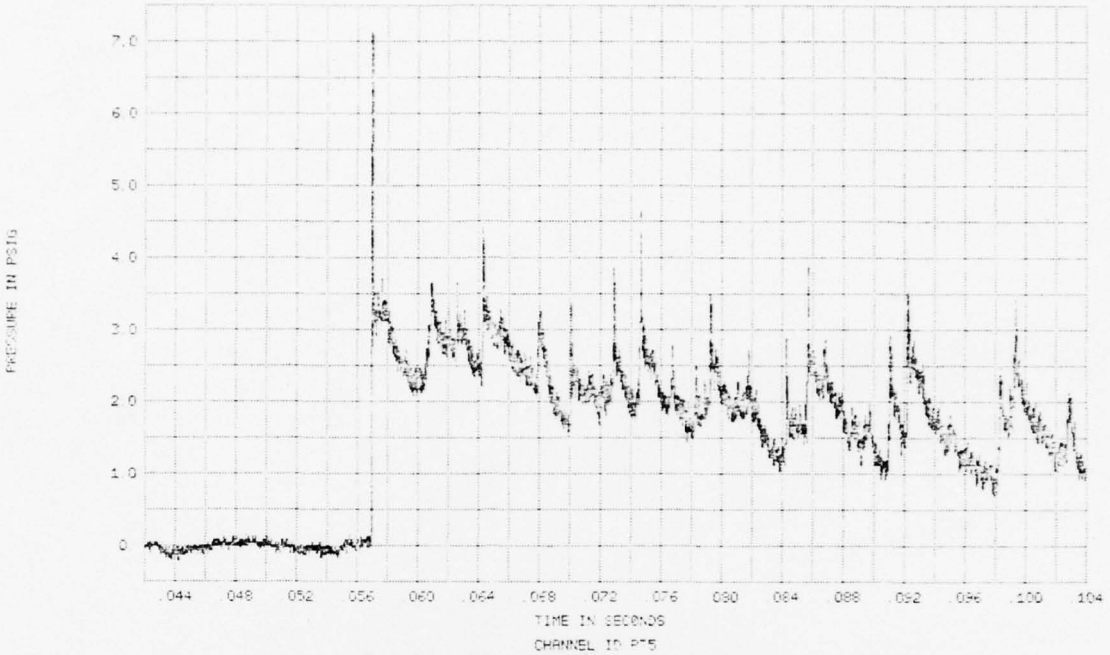


FIGURE 1-19 , SPECIMEN NO. 1 , SHOT NO 2 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

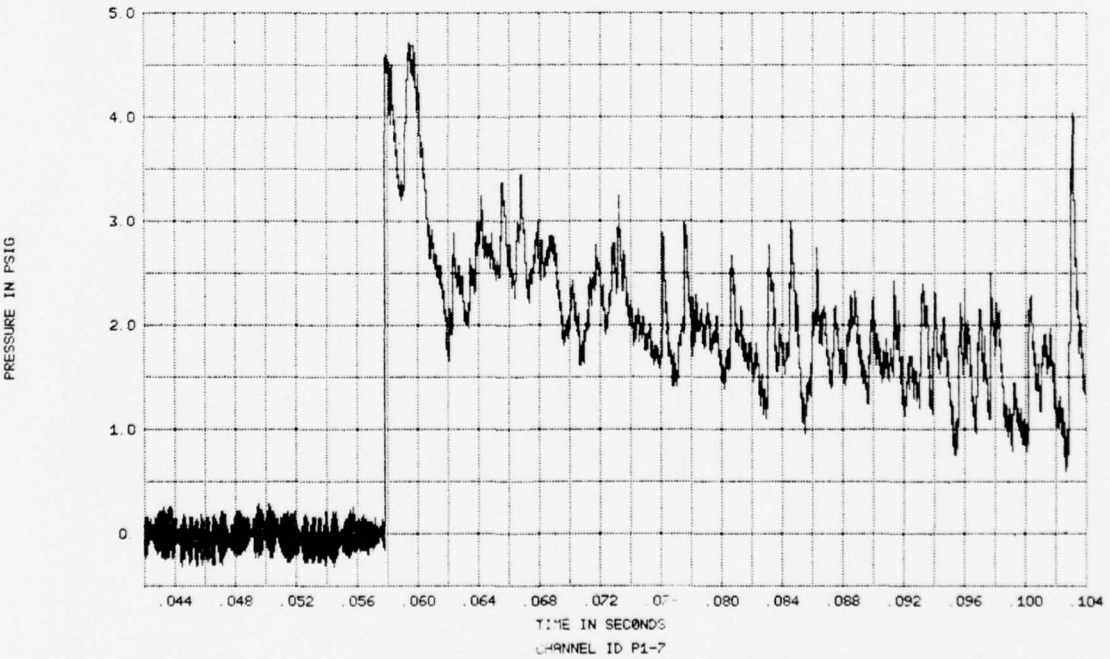


FIGURE 1-20 , SPECIMEN NO. 1 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

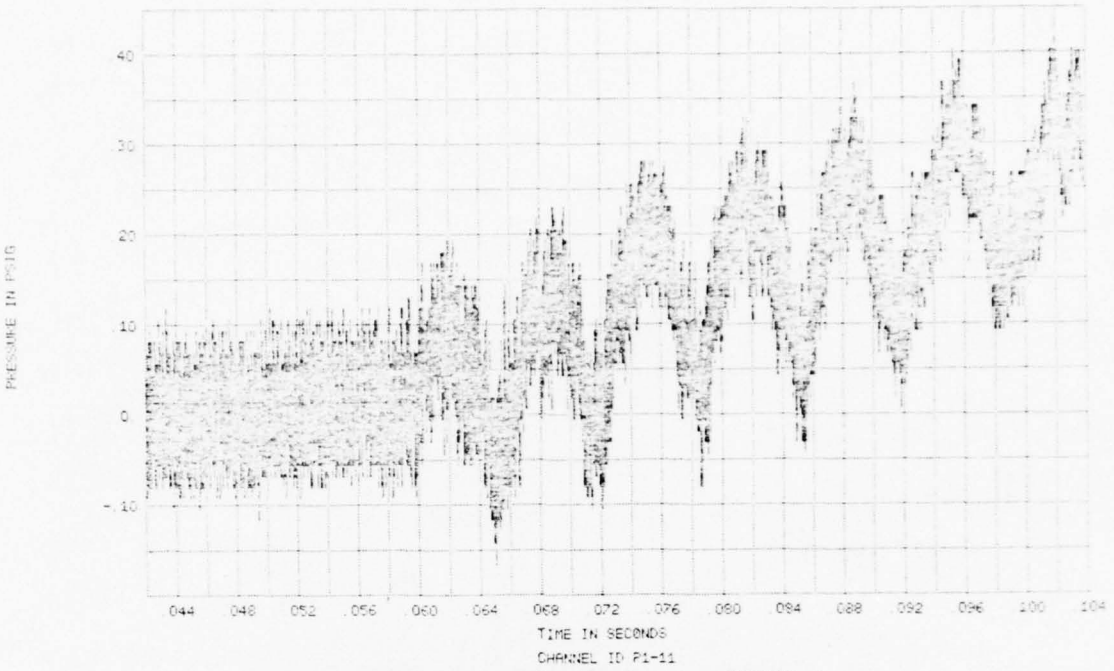


FIGURE 1-21 , SPECIMEN NO. 1 , SHOT NO. 2 ,
INTERNAL PRESSURE TIME HISTORY

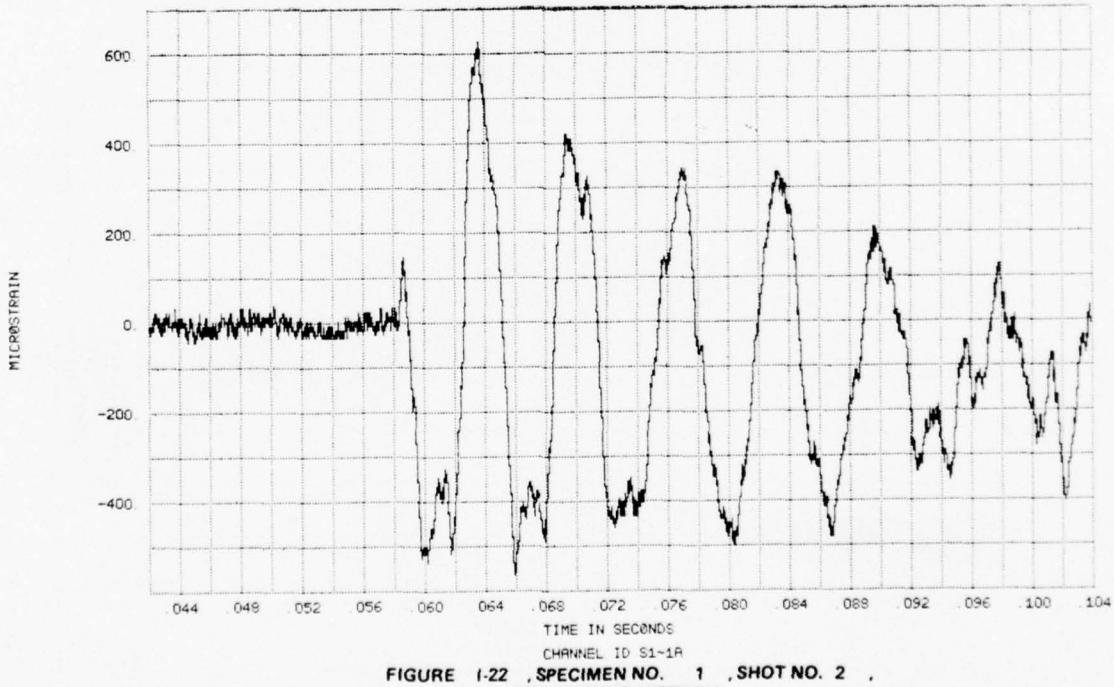


FIGURE 1-22 , SPECIMEN NO. 1 , SHOT NO. 2 ,
STRAIN TIME HISTORY

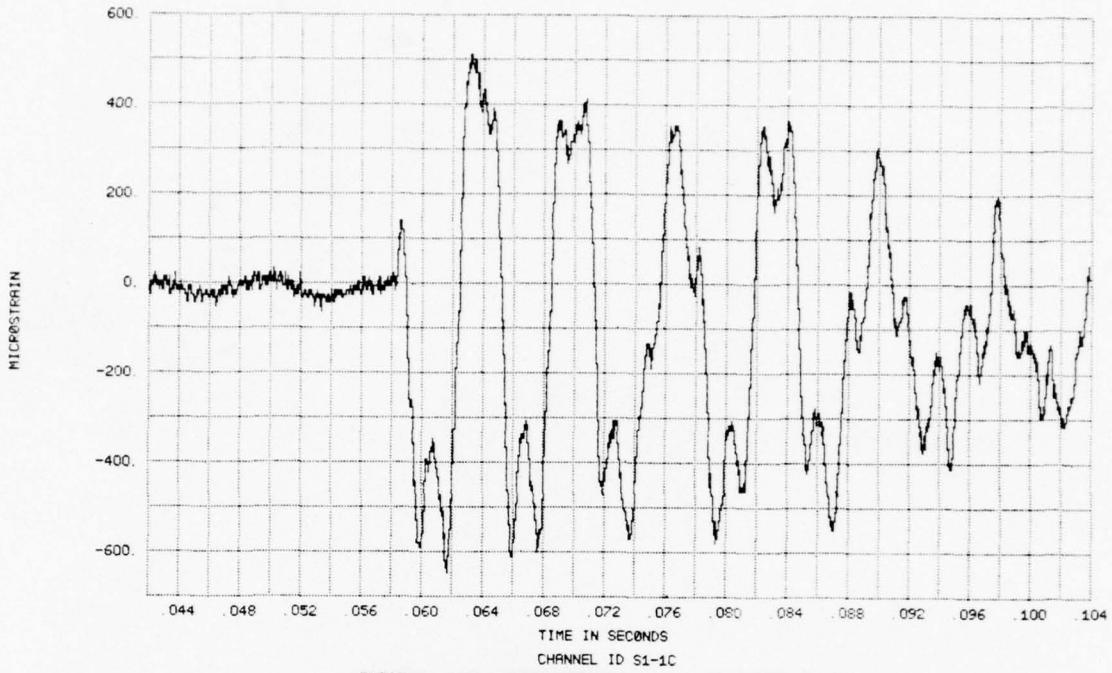


FIGURE 1-23 , SPECIMEN NO. 1 , SHOT NO. 2 ,
STRAIN TIME HISTORY

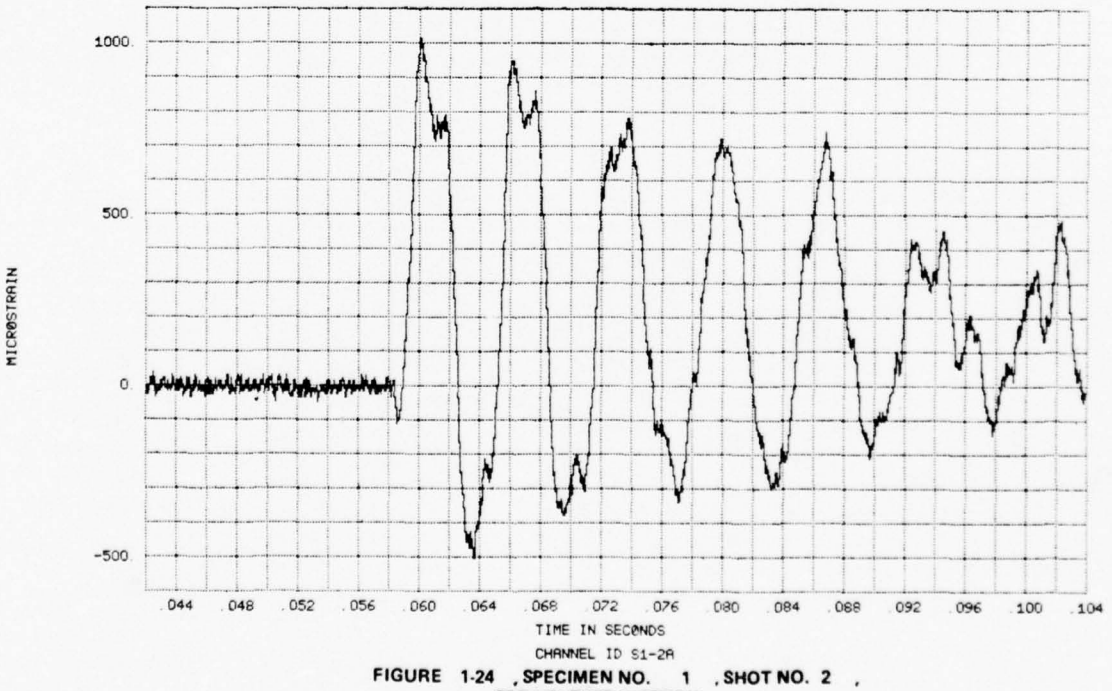


FIGURE 1-24 , SPECIMEN NO. 1 , SHOT NO. 2 ,
STRAIN TIME HISTORY

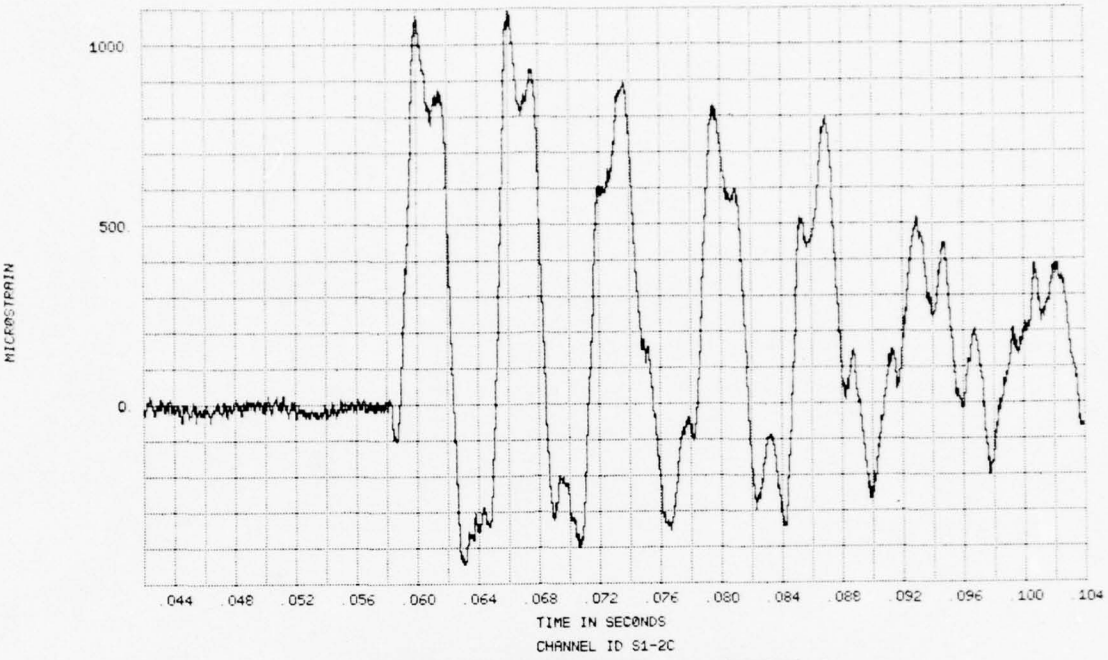


FIGURE 1-25 , SPECIMEN NO. 1 , SHOT NO. 2 , STRAIN TIME HISTORY

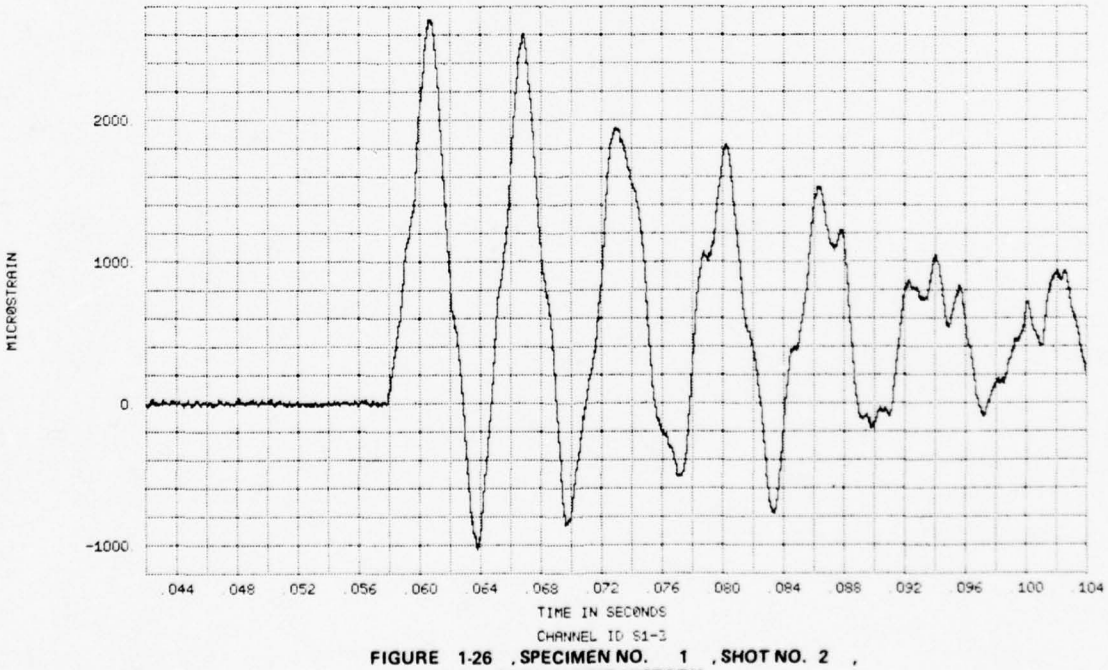


FIGURE 1-26 , SPECIMEN NO. 1 , SHOT NO. 2 , STRAIN TIME HISTORY

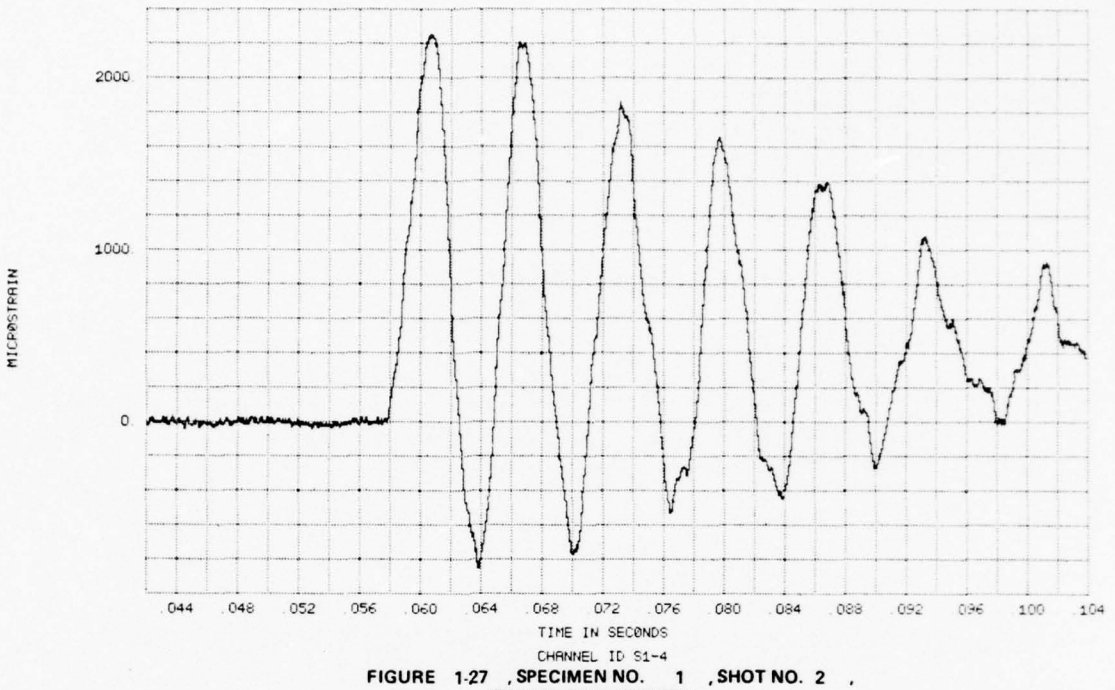


FIGURE 1-27 , SPECIMEN NO. 1 , SHOT NO. 2 ,
STRAIN TIME HISTORY

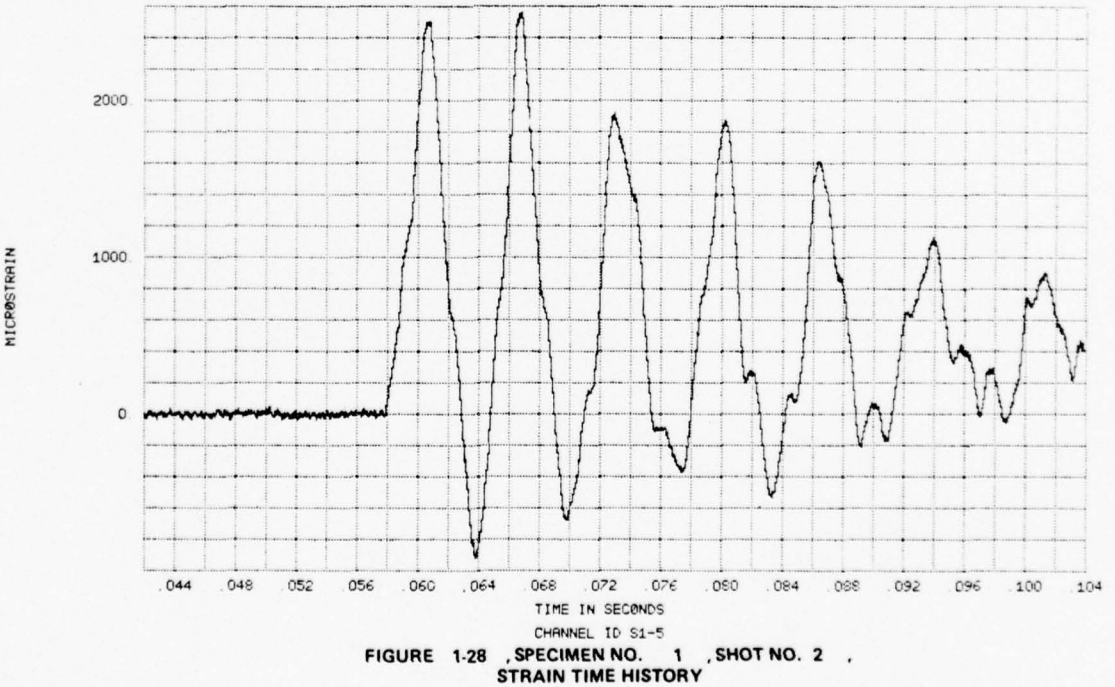


FIGURE 1-28 , SPECIMEN NO. 1 , SHOT NO. 2 ,
STRAIN TIME HISTORY

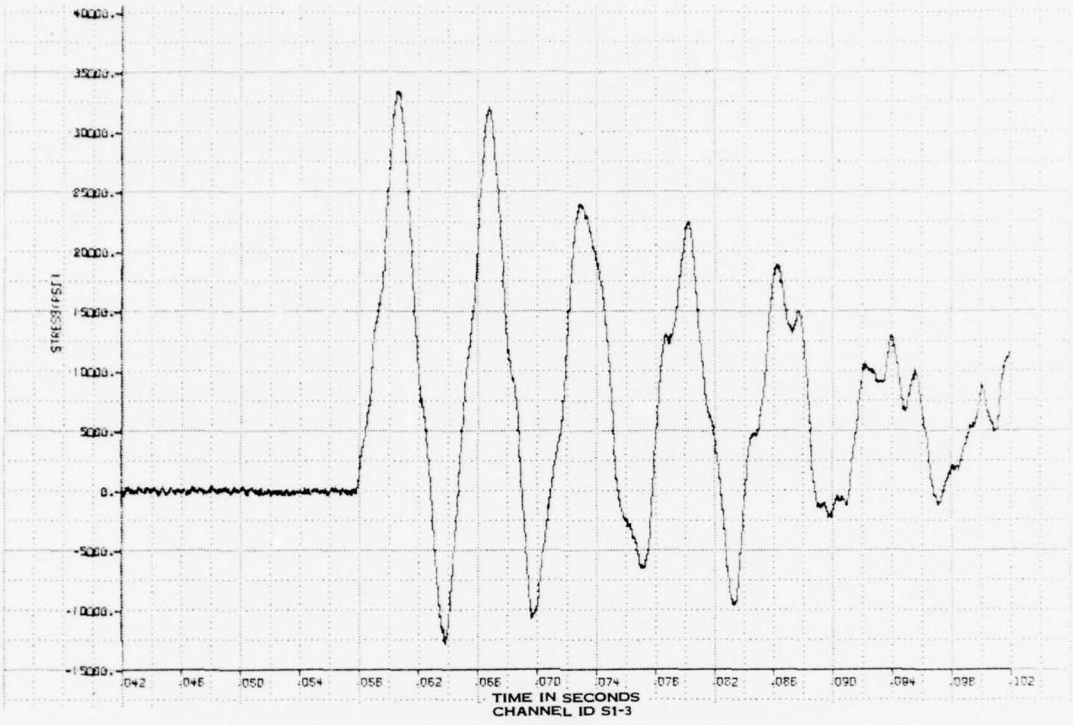


FIGURE 1-29 , SPECIMEN NO. 1 , SHOT NO. 2 ,
STRESS TIME HISTORY

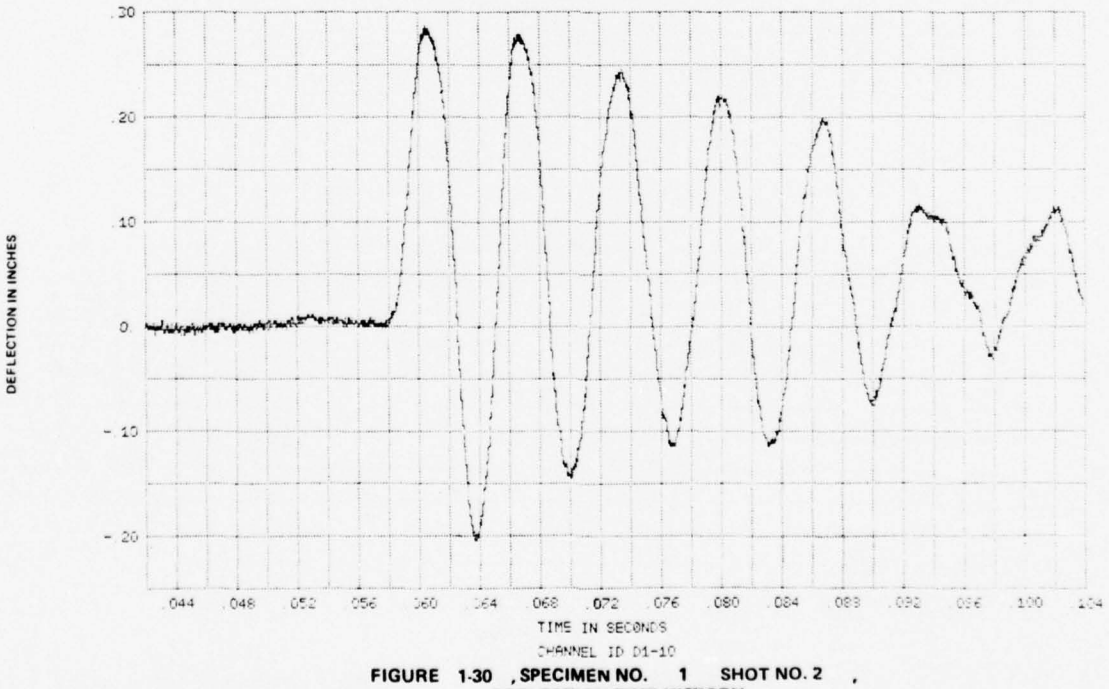


FIGURE 1-30 , SPECIMEN NO. 1 SHOT NO. 2 ,
DEFLECTION TIME HISTORY

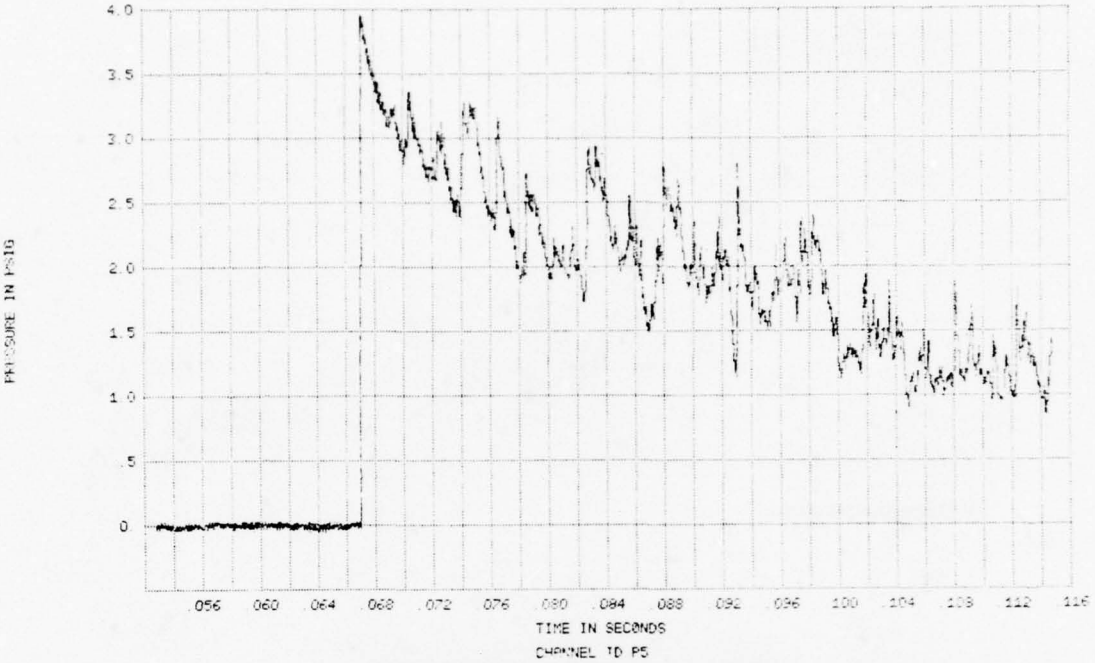


FIGURE 1-31 , SPECIMEN NO. 1 , SHOT NO. 3 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

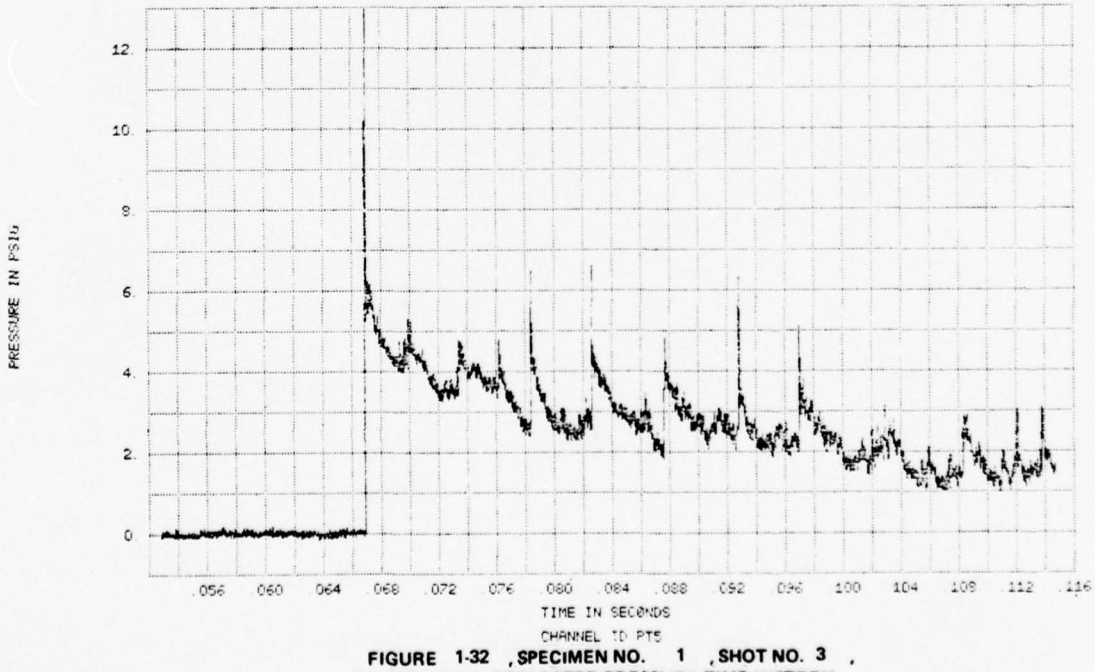


FIGURE 1-32 , SPECIMEN NO. 1 , SHOT NO. 3 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

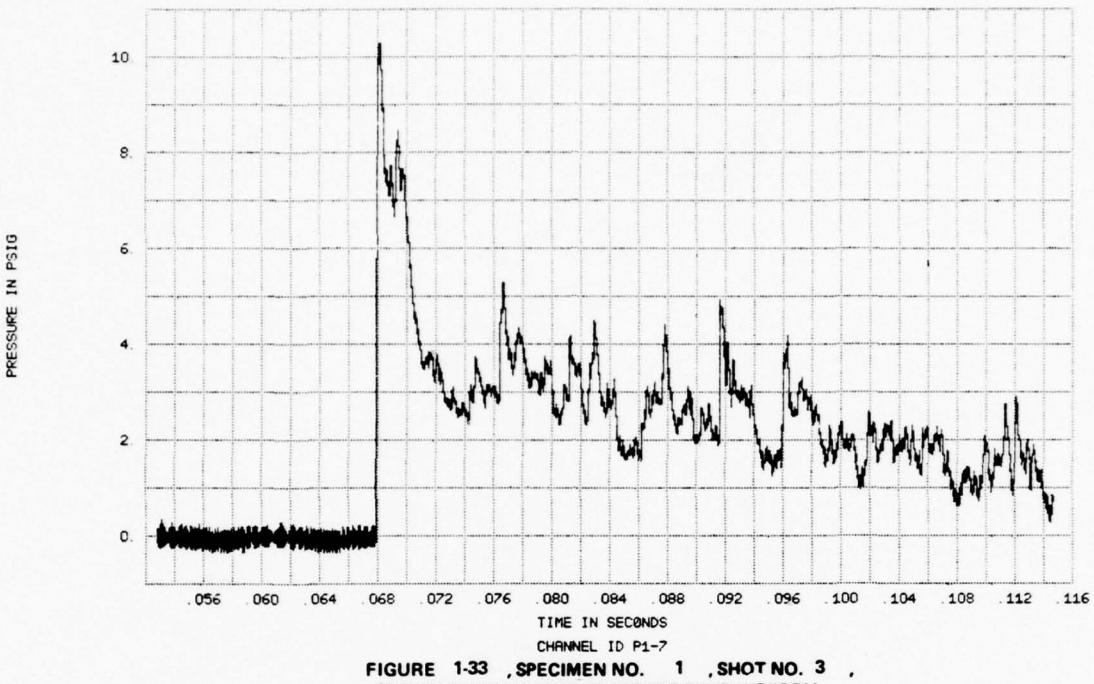


FIGURE 1-33 , SPECIMEN NO. 1 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

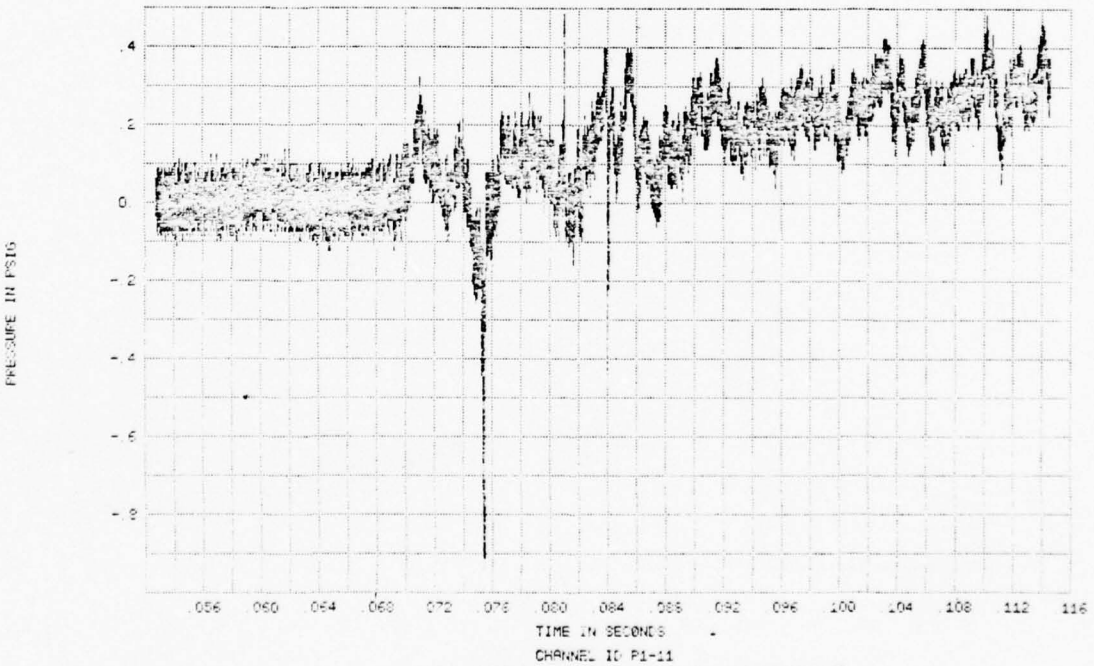


FIGURE 1-34 , SPECIMEN NO. 1 , SHOT NO. 3 ,
INTERNAL PRESSURE TIME HISTORY

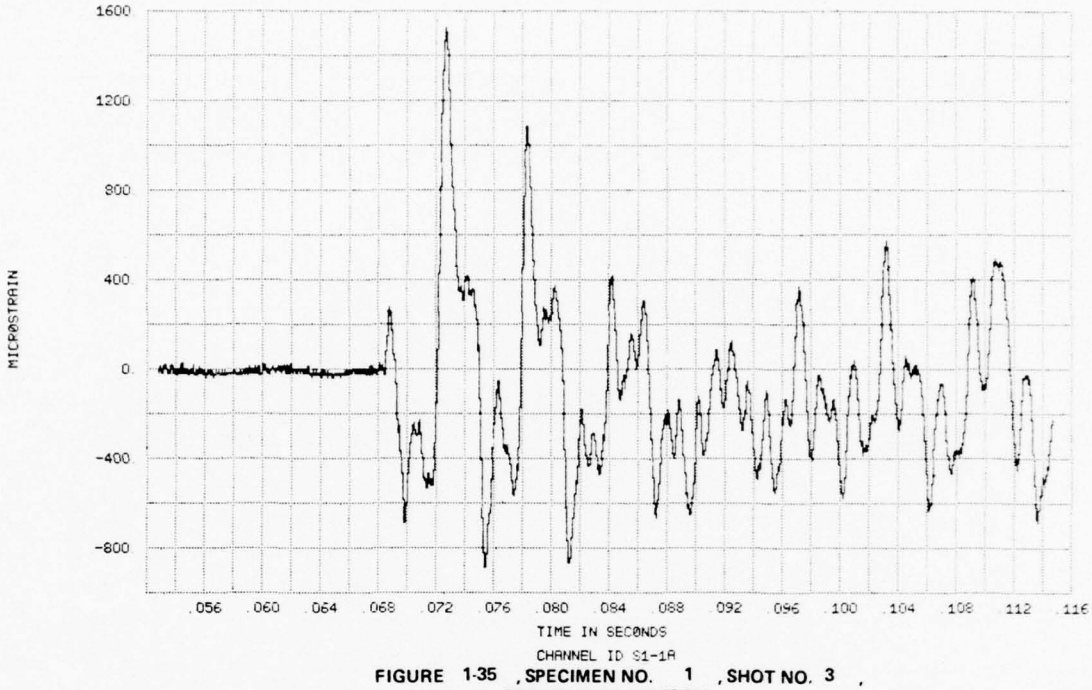


FIGURE 1-35 , SPECIMEN NO. 1 , SHOT NO. 3 ,
STRAIN TIME HISTORY

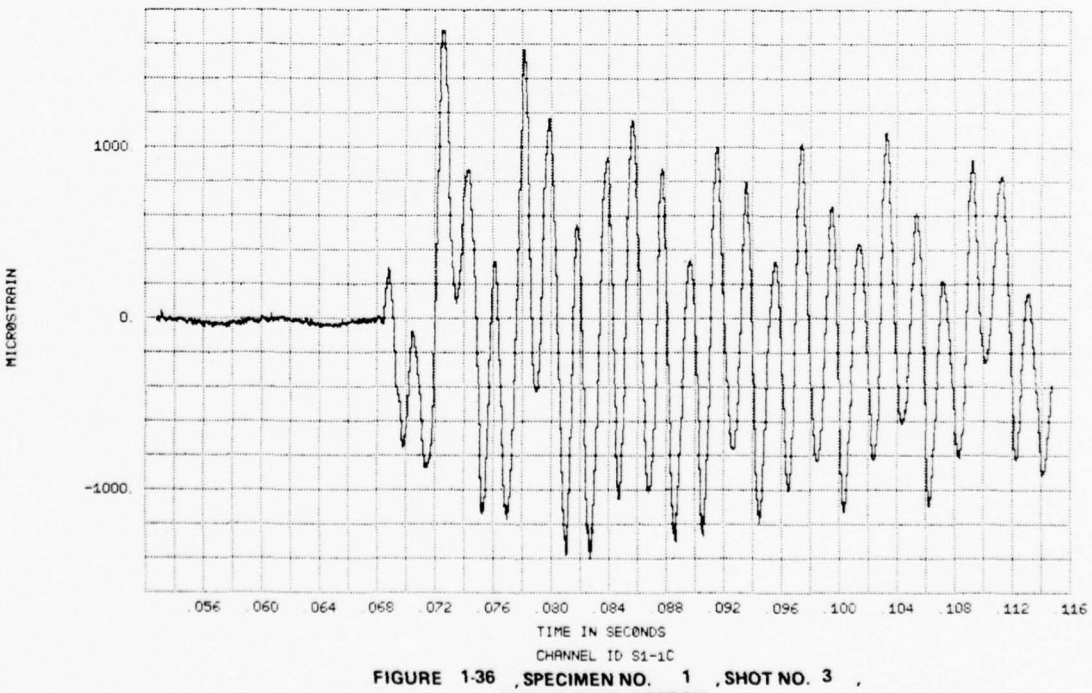


FIGURE 1-36 , SPECIMEN NO. 1 , SHOT NO. 3 ,
STRAIN TIME HISTORY

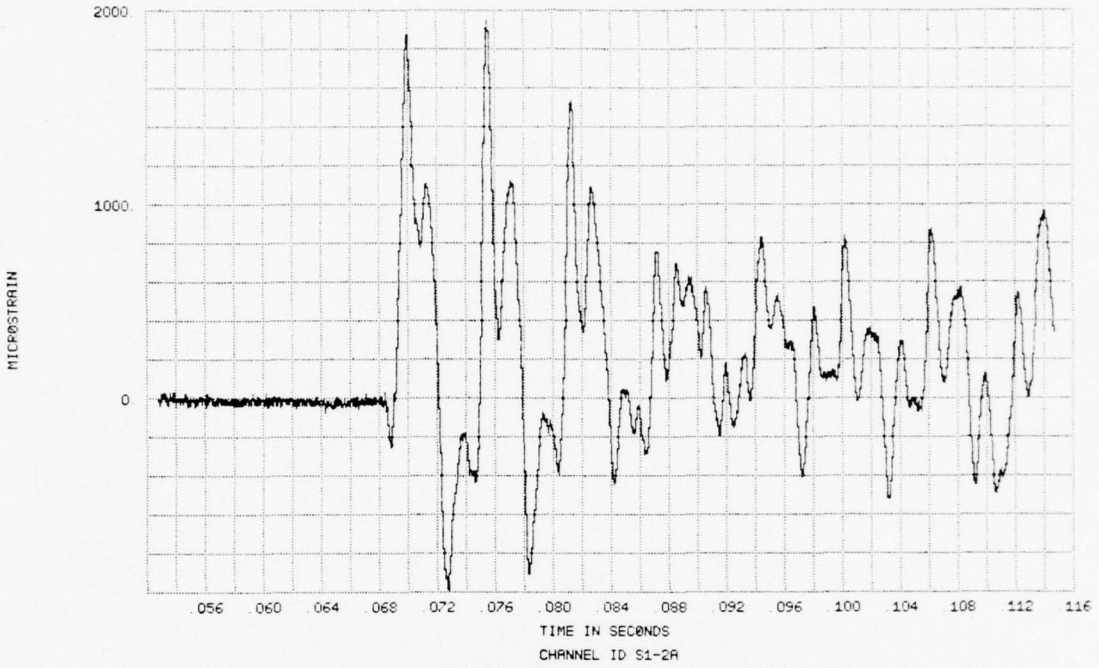


FIGURE 1-37 , SPECIMEN NO. 1 , SHOT NO. 3 ,
STRAIN TIME HISTORY

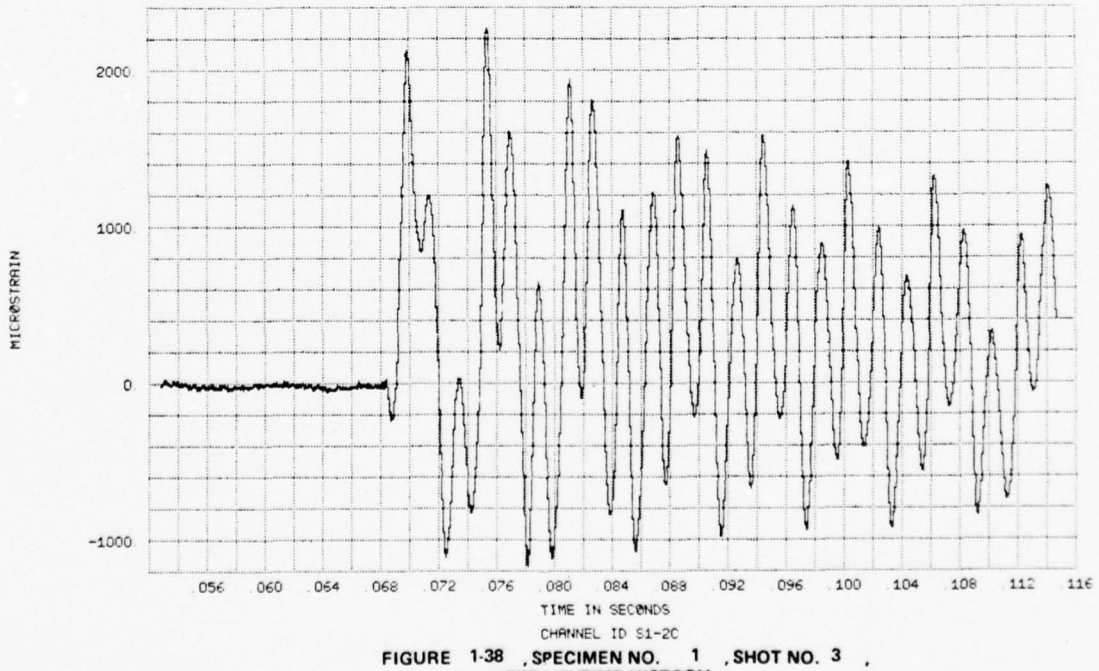


FIGURE 1-38 , SPECIMEN NO. 1 , SHOT NO. 3 ,
STRAIN TIME HISTORY

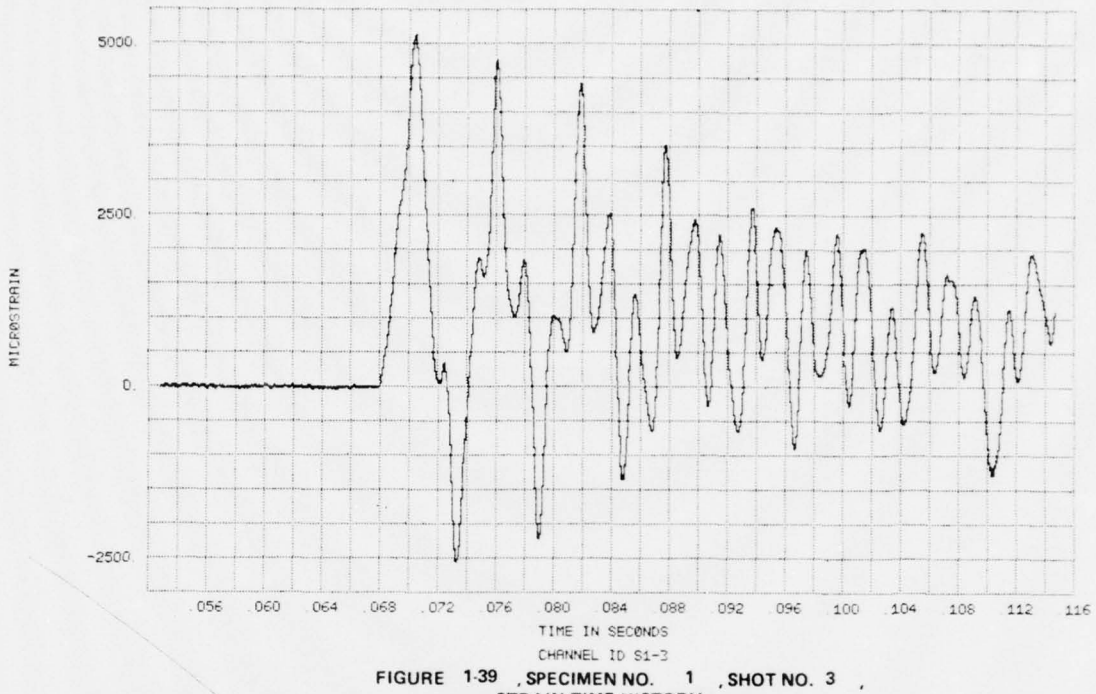


FIGURE 1-39 , SPECIMEN NO. 1 , SHOT NO. 3 ,
STRAIN TIME HISTORY

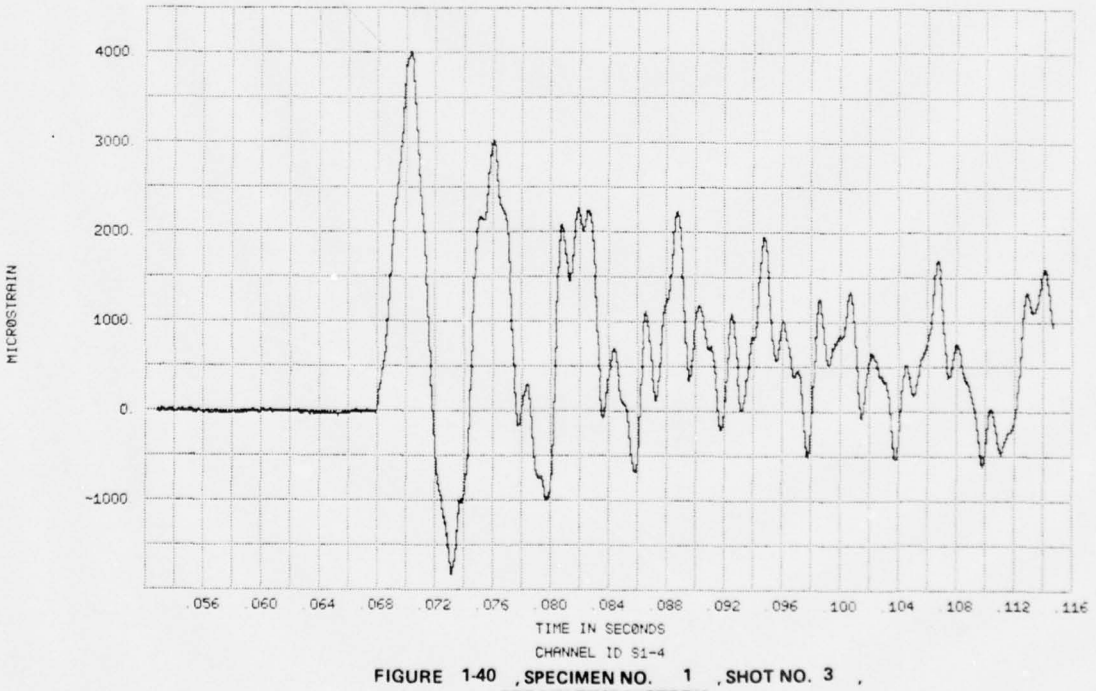


FIGURE 1-40 , SPECIMEN NO. 1 , SHOT NO. 3 ,
STRAIN TIME HISTORY

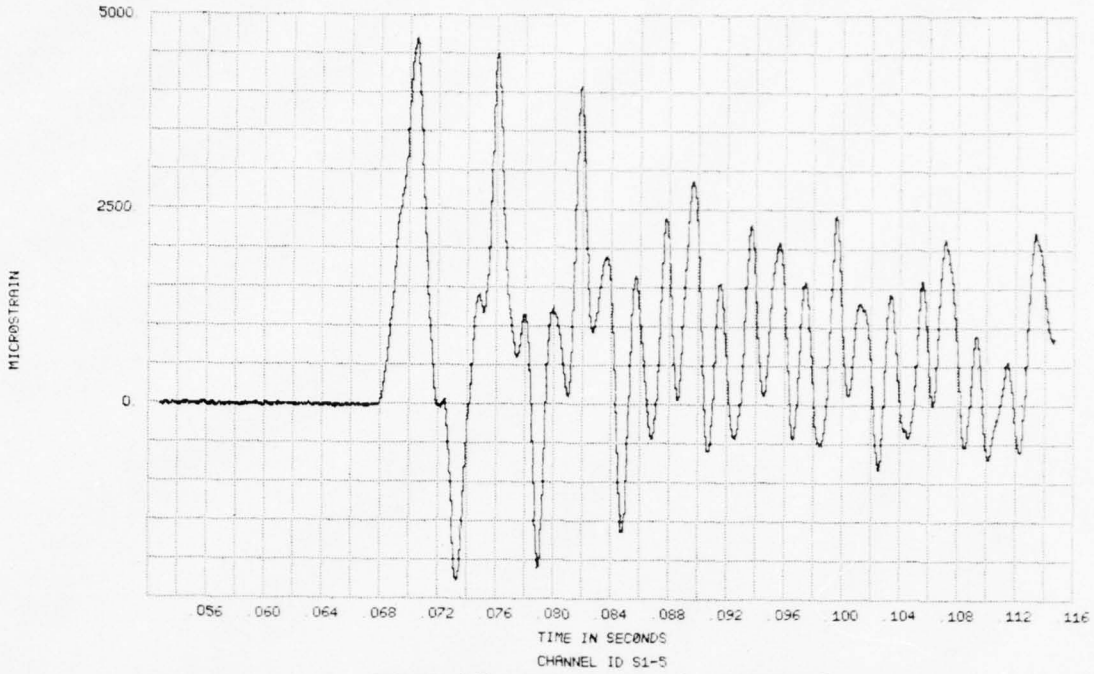


FIGURE 1-41 , SPECIMEN NO. 1 , SHOT NO. 3 ,
STRAIN TIME HISTORY

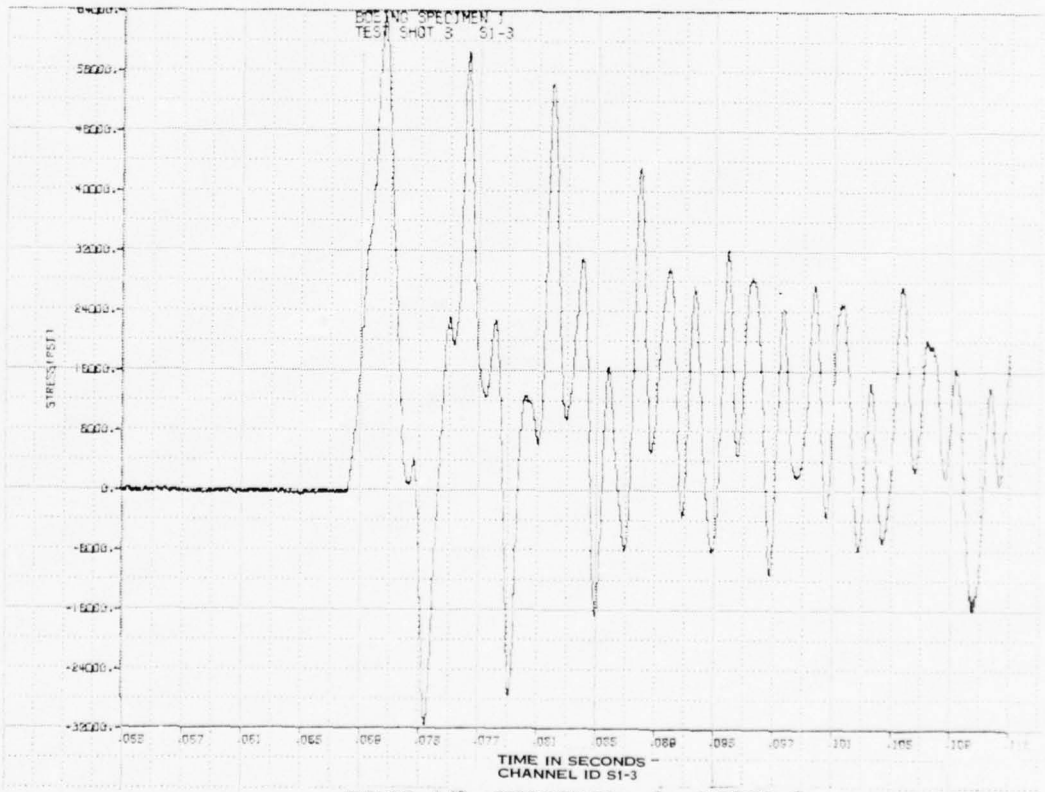


FIGURE 1-42 , SPECIMEN NO. 1 , SHOT NO. 3 ,
STRESS TIME HISTORY

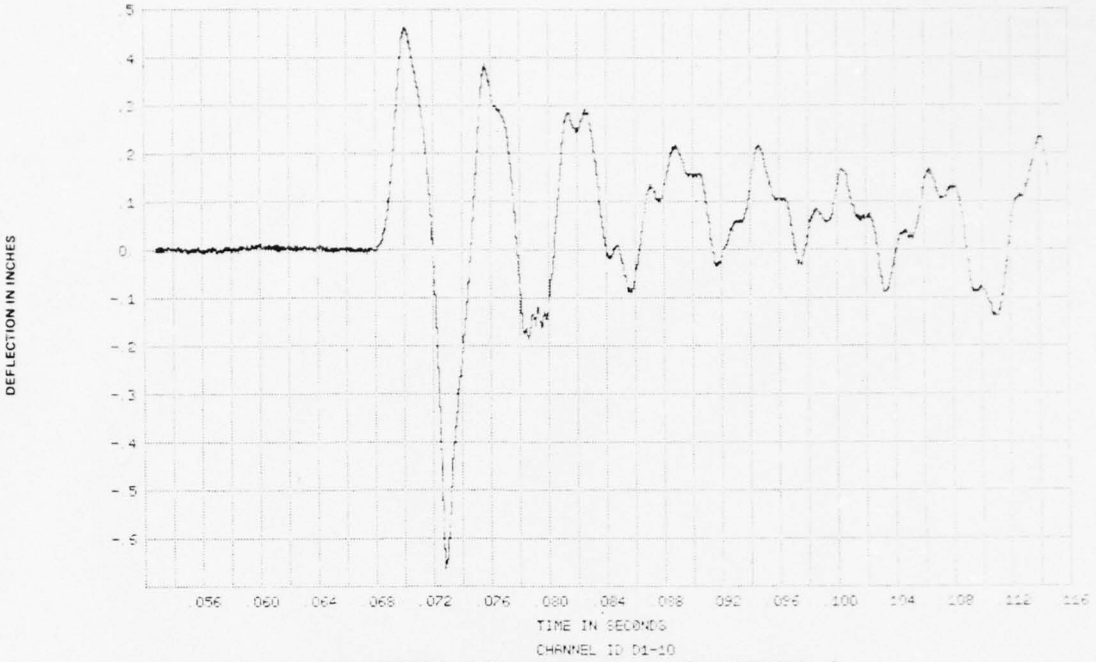


FIGURE 1-43 , SPECIMEN NO. 1 , SHOT NO. 3 ,
DEFLECTION TIME HISTORY

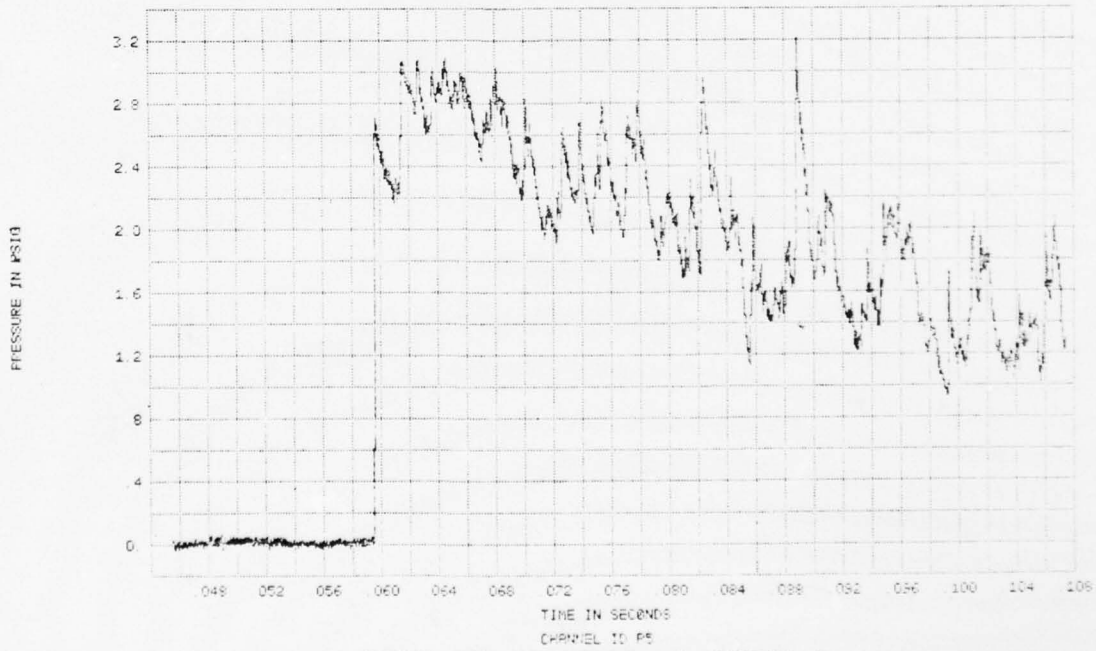


FIGURE 1-44 , SPECIMEN NO. 1 , SHOT NO. 4 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

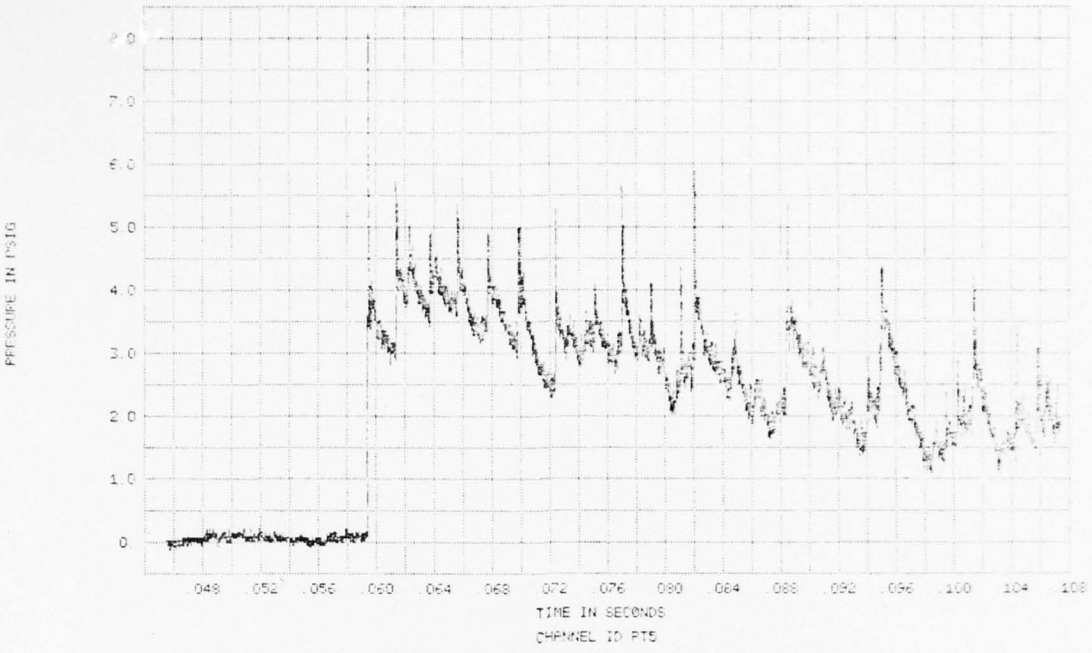


FIGURE 1-45 , SPECIMEN NO. 1 , SHOT NO. 4 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

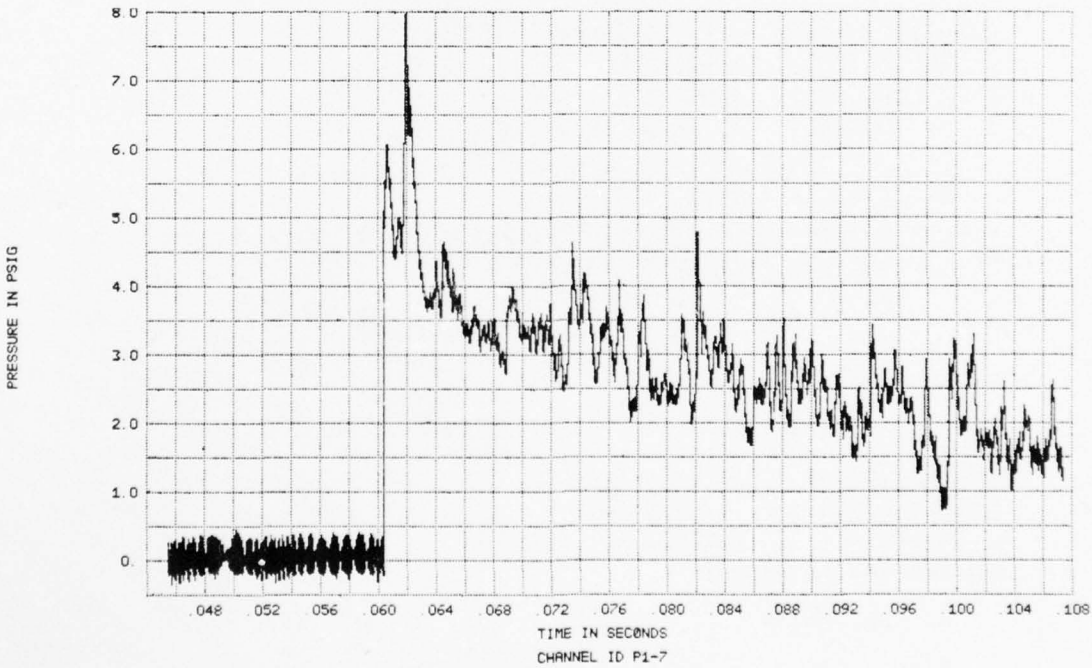


FIGURE 1-46 , SPECIMEN NO. 1 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

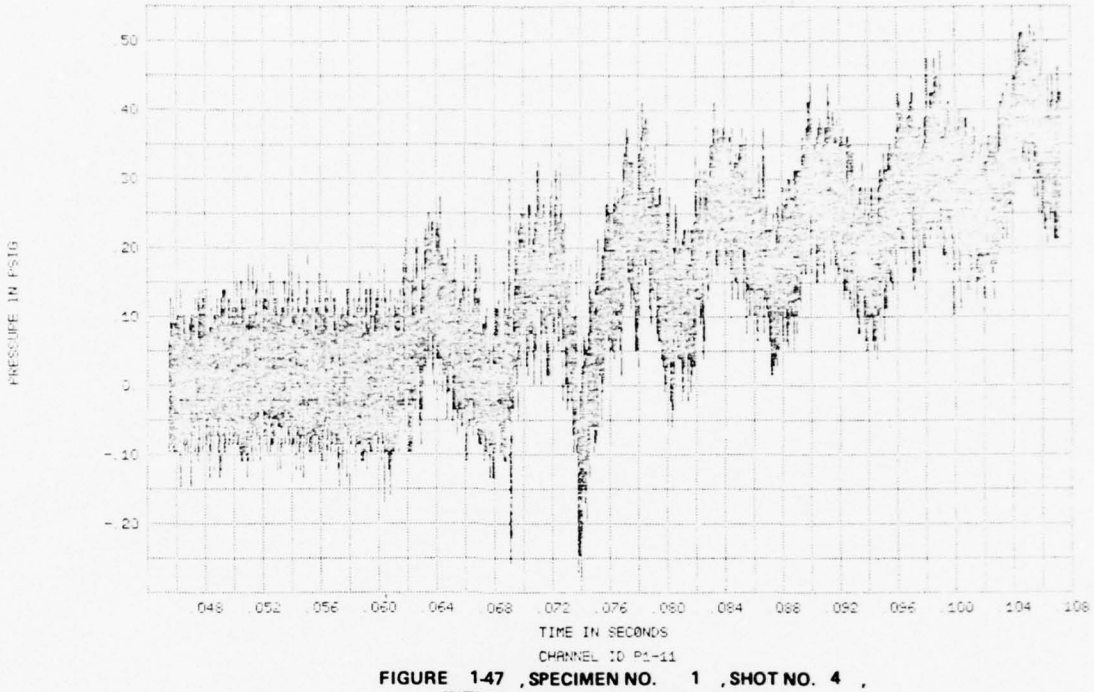


FIGURE 1-47 , SPECIMEN NO. 1 , SHOT NO. 4 ,
INTERNAL PRESSURE TIME HISTORY

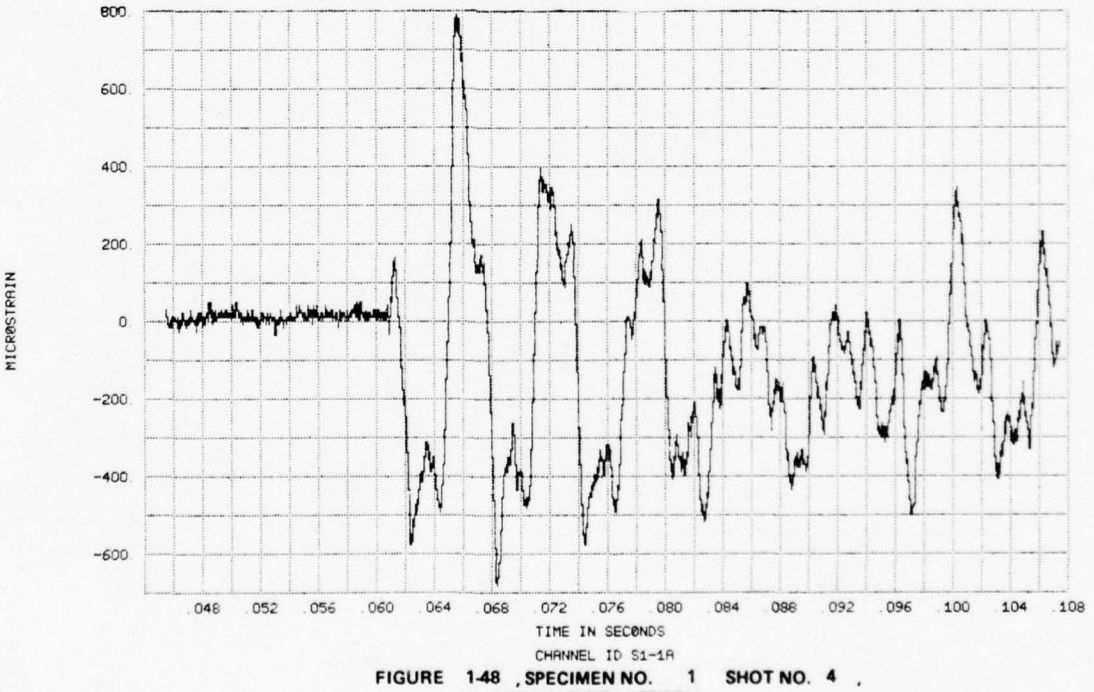


FIGURE 1-48 , SPECIMEN NO. 1 SHOT NO. 4 ,
STRAIN TIME HISTORY

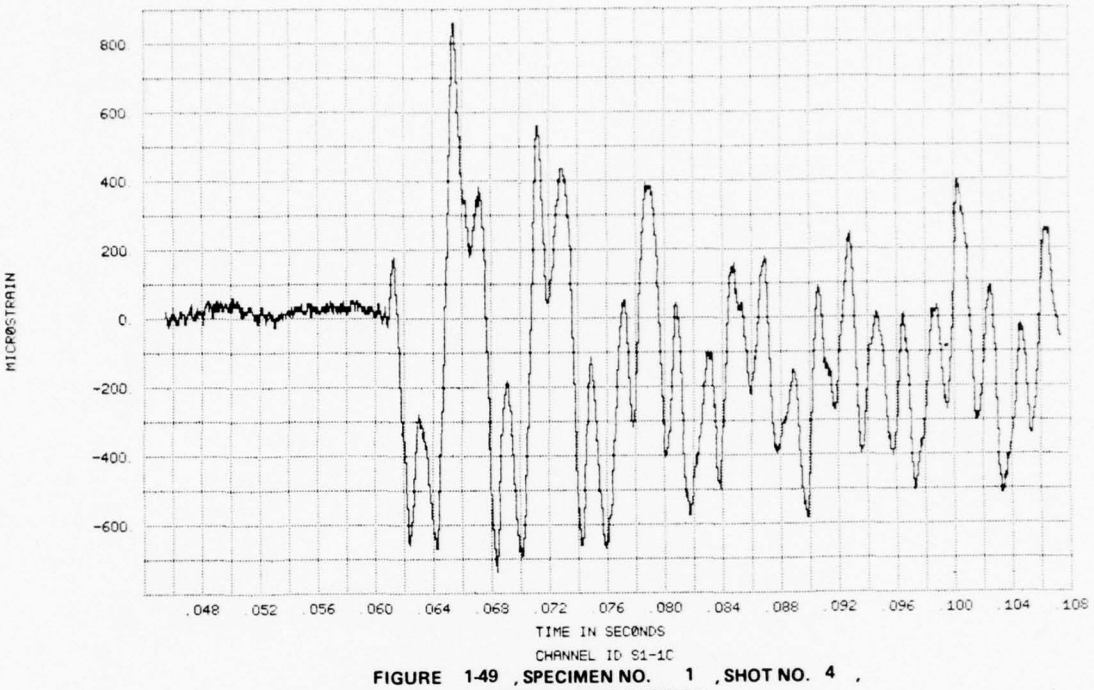


FIGURE 1-49 , SPECIMEN NO. 1 , SHOT NO. 4 ,
STRAIN TIME HISTORY

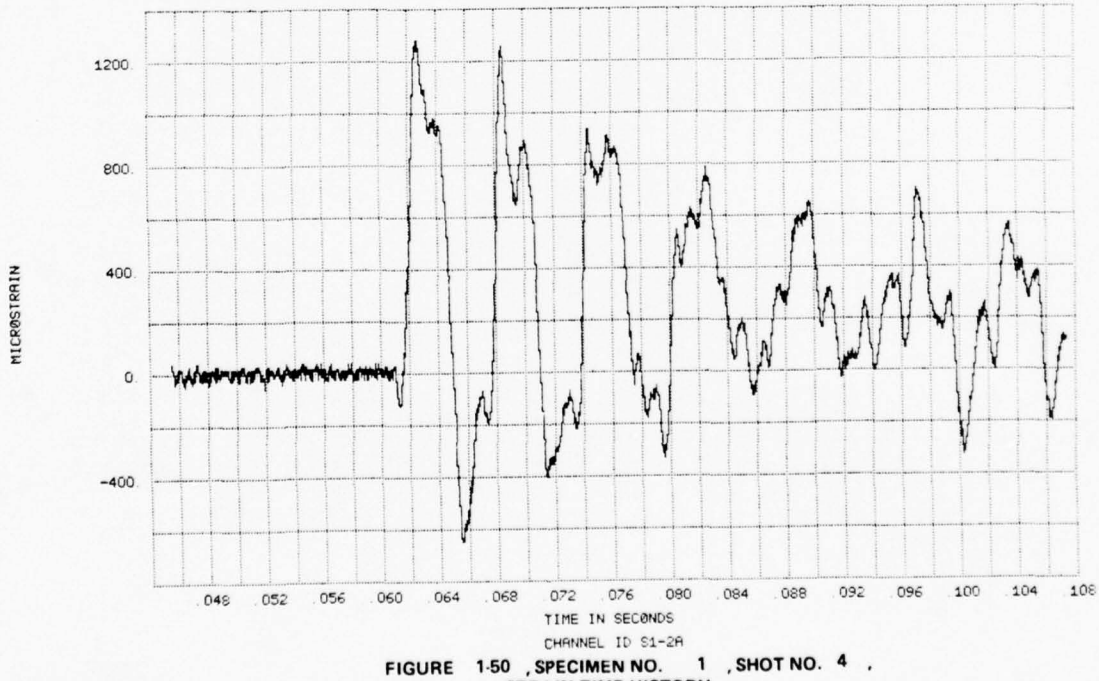


FIGURE 1-50 , SPECIMEN NO. 1 , SHOT NO. 4 ,
STRAIN TIME HISTORY

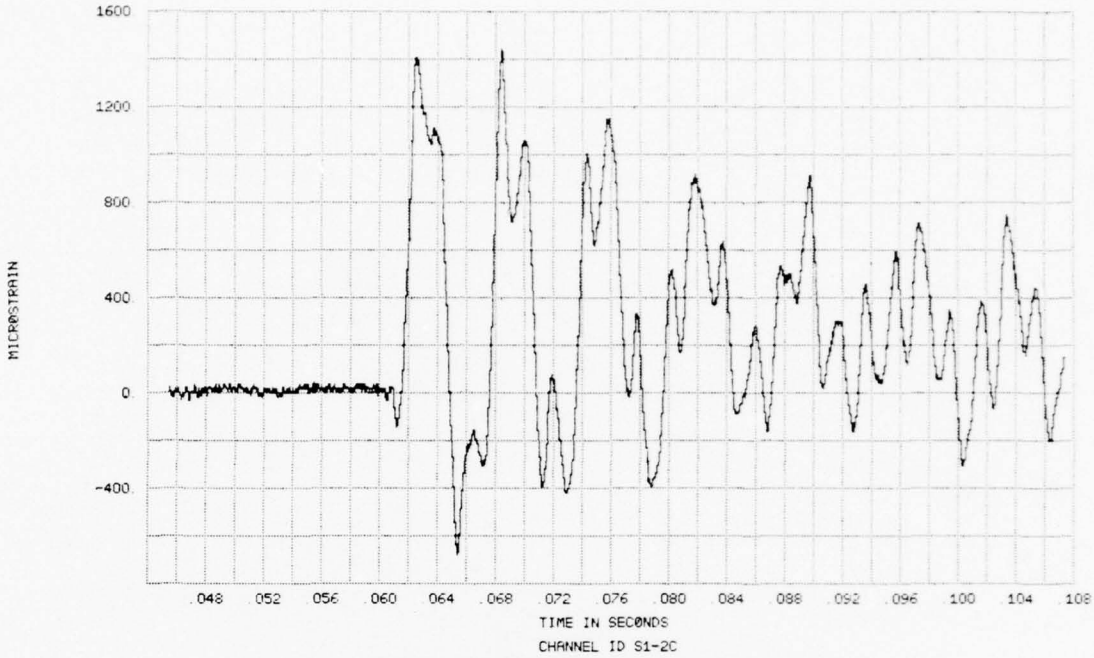


FIGURE 1-51 , SPECIMEN NO. 1 , SHOT NO. 4 , STRAIN TIME HISTORY

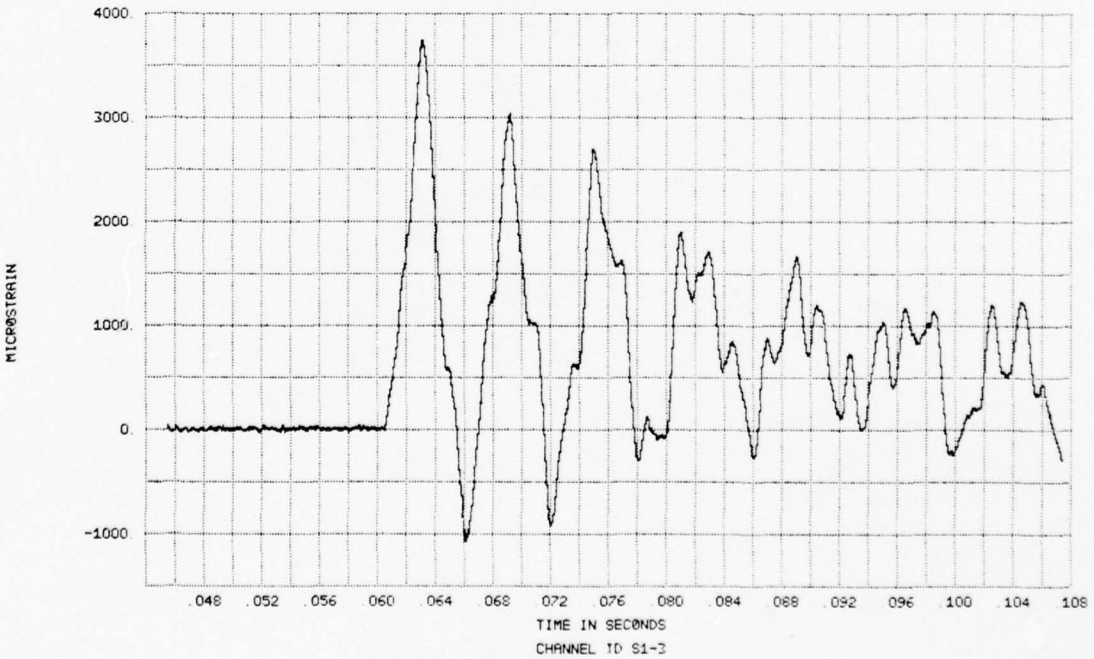


FIGURE 1-52 , SPECIMEN NO. 1 , SHOT NO. 4 , STRAIN TIME HISTORY

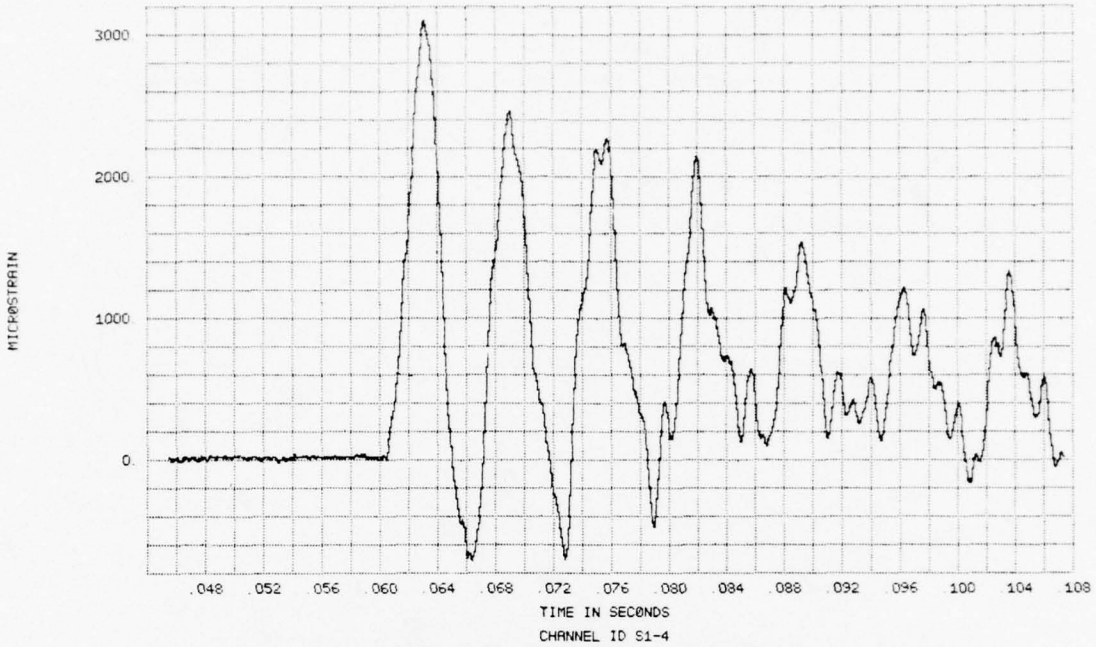


FIGURE 1-53 , SPECIMEN NO. 1 , SHOT NO. 4 , STRAIN TIME HISTORY

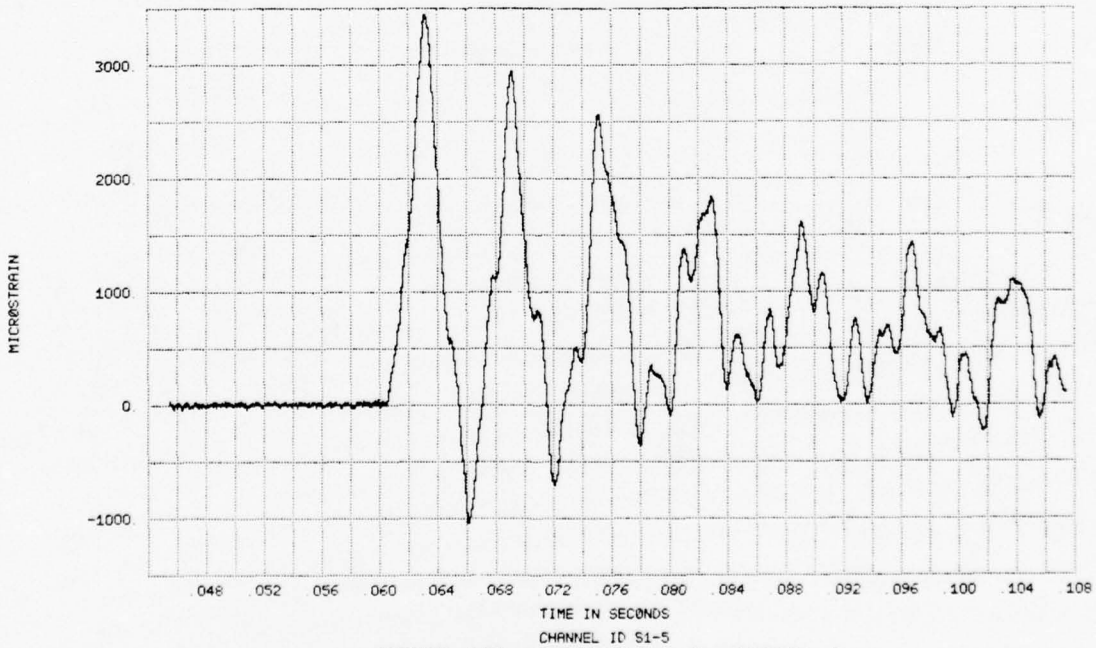


FIGURE 1-54 , SPECIMEN NO. 1 , SHOT NO. 4 , STRAIN TIME HISTORY

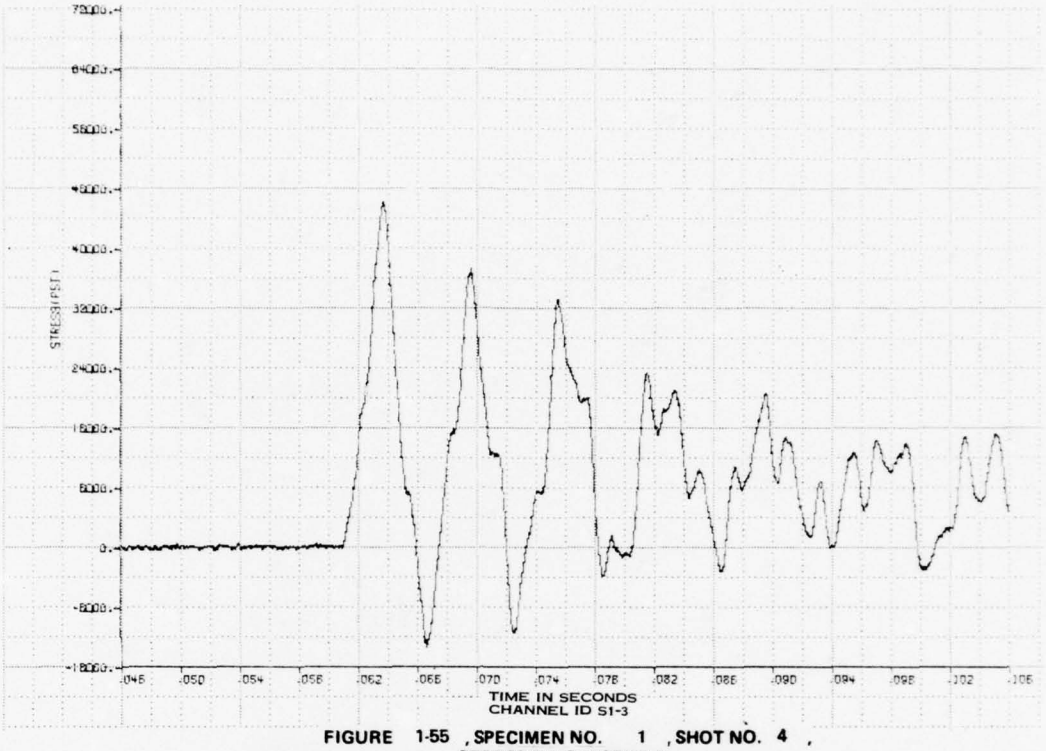


FIGURE 1-55 , SPECIMEN NO. 1 , SHOT NO. 4 ,
STRESS TIME HISTORY

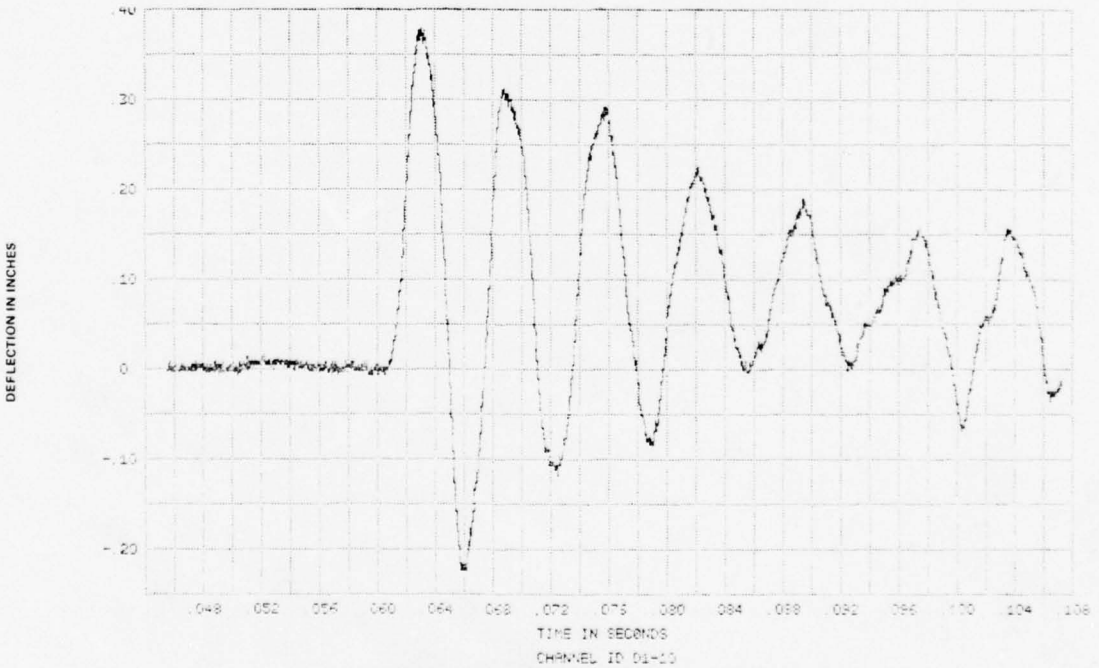


FIGURE 1-56 , SPECIMEN NO. 1 , SHOT NO. 4 ,
DEFLECTION TIME HISTORY

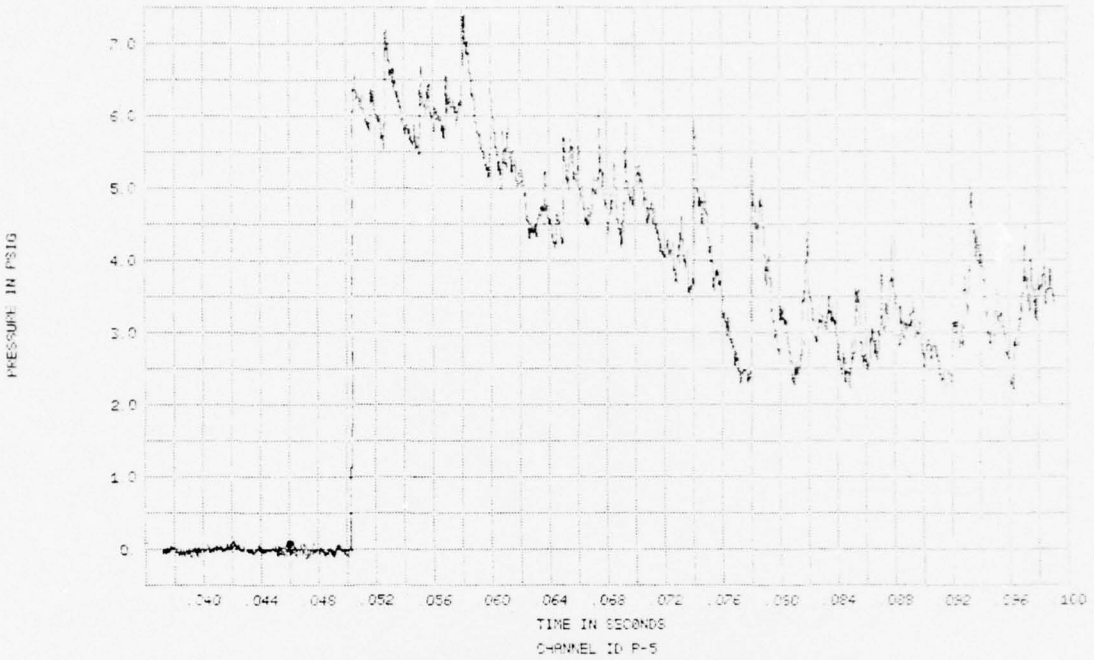


FIGURE 1-57 , SPECIMEN NO. 1 , SHOT NO. 5 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

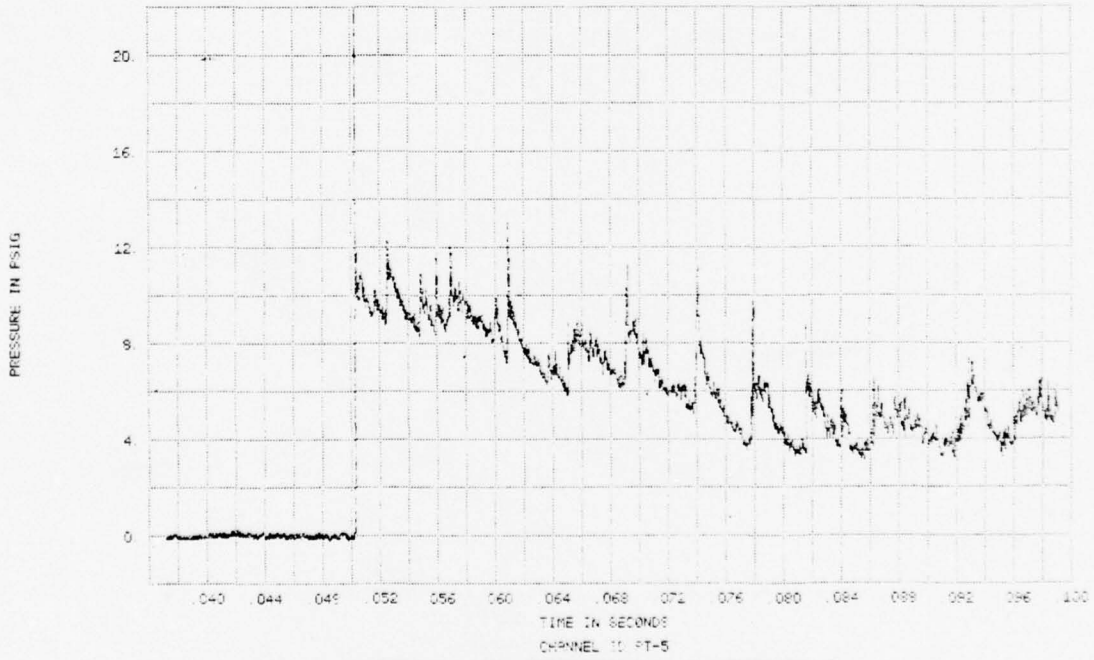


FIGURE 1-58 , SPECIMEN NO. 1 , SHOT NO. 5 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

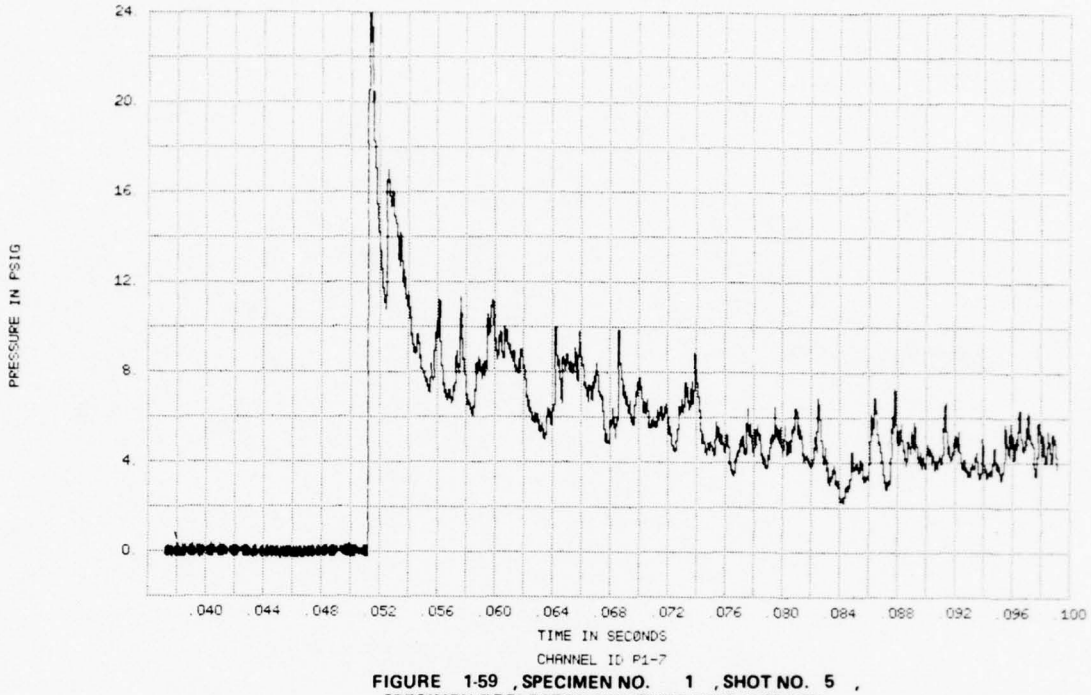


FIGURE 1-59 , SPECIMEN NO. 1 , SHOT NO. 5 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

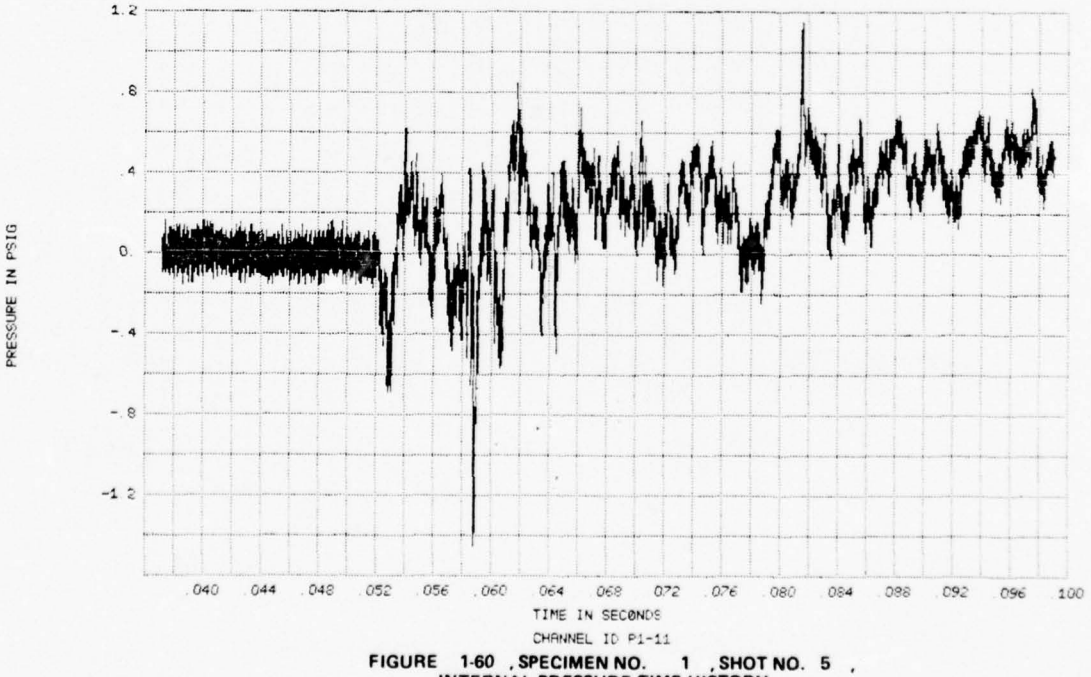


FIGURE 1-60 , SPECIMEN NO. 1 , SHOT NO. 5 ,
INTERNAL PRESSURE TIME HISTORY

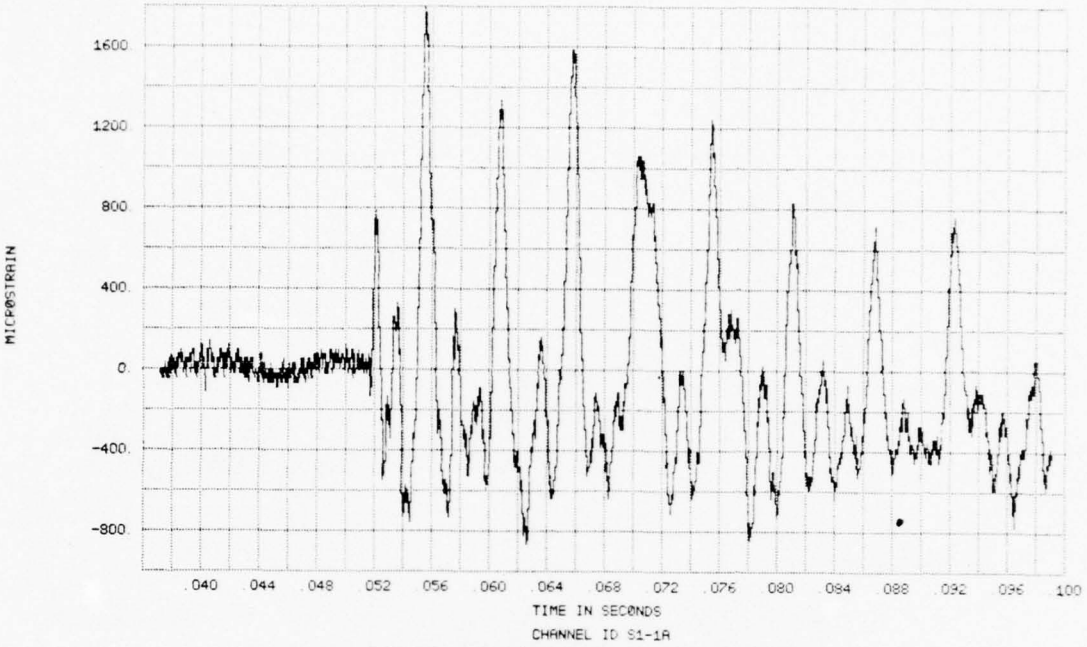


FIGURE 1-61 , SPECIMEN NO. 1 , SHOT NO. 5 ,
STRAIN TIME HISTORY

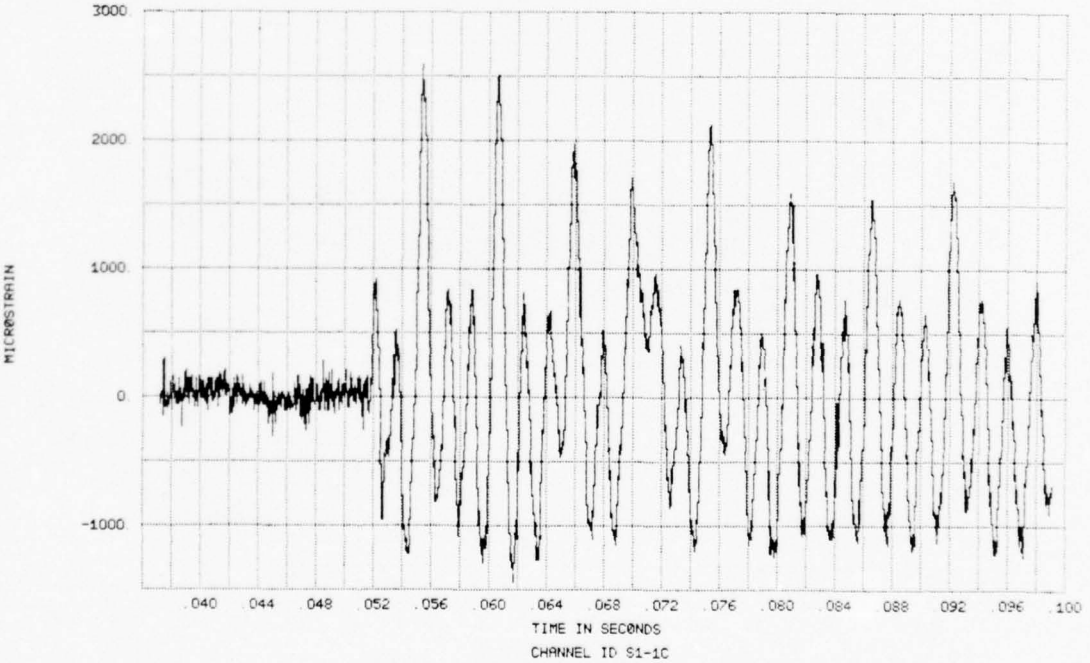


FIGURE 1-62 , SPECIMEN NO. 1 , SHOT NO. 5 ,
STRAIN TIME HISTORY

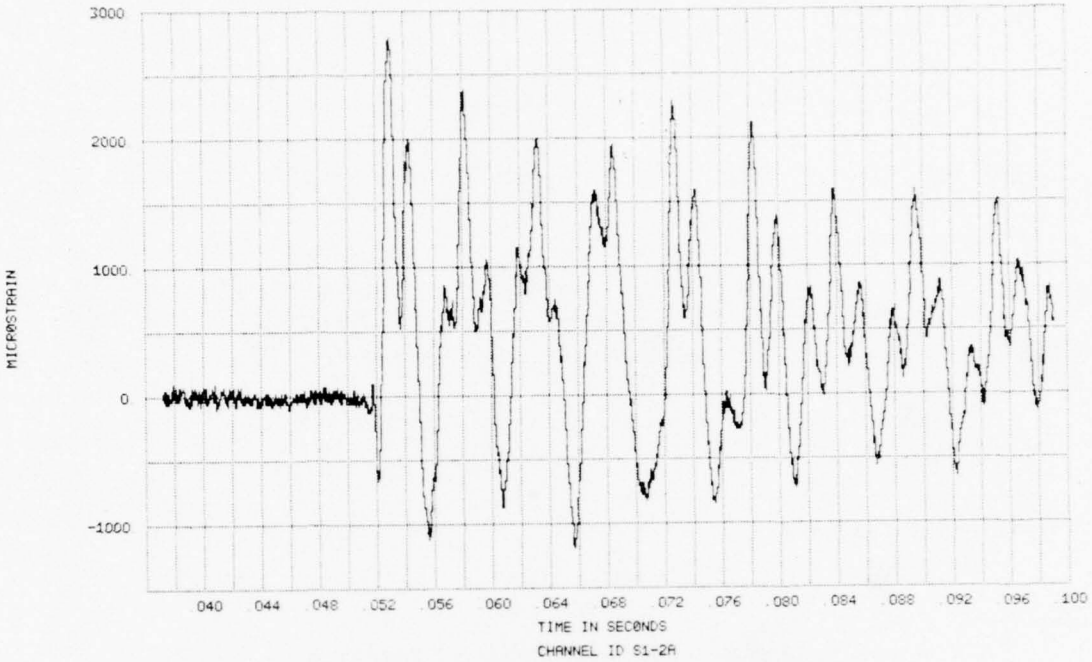


FIGURE 1-63 , SPECIMEN NO. 1 , SHOT NO. 5 ,
STRAIN TIME HISTORY

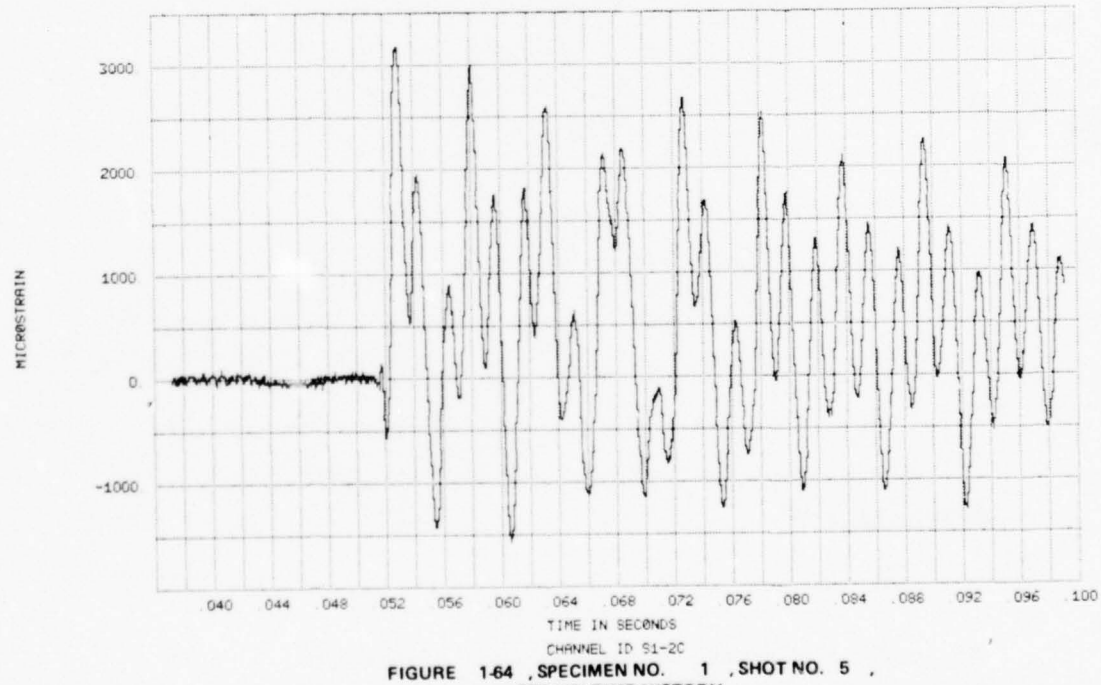


FIGURE 1-64 , SPECIMEN NO. 1 , SHOT NO. 5 ,
STRAIN TIME HISTORY

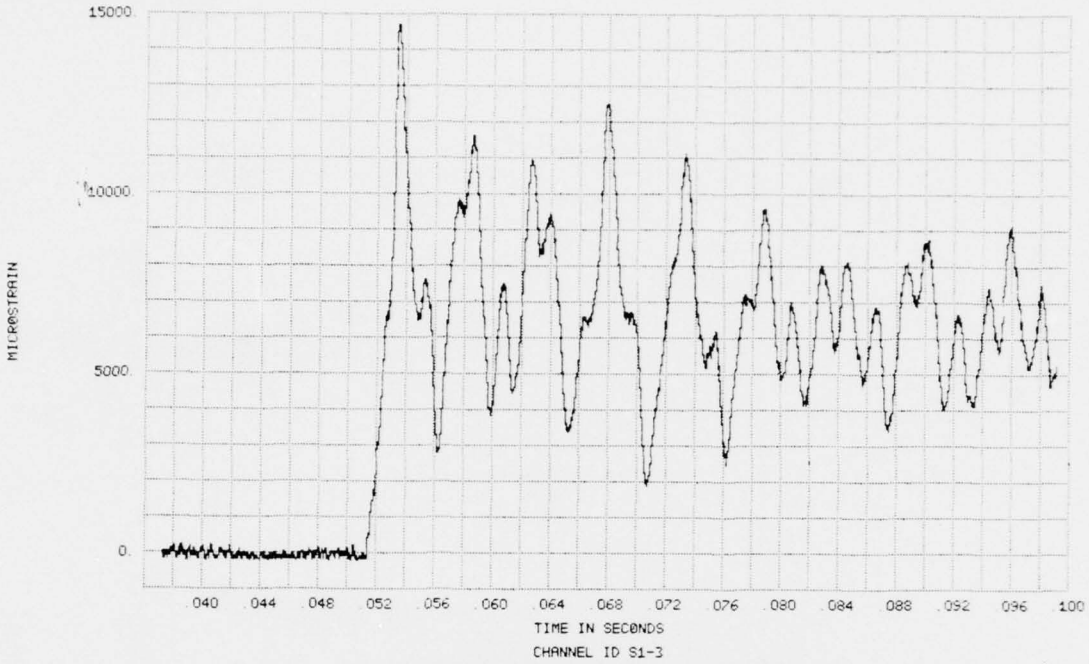


FIGURE 1-65 , SPECIMEN NO. 1 , SHOT NO. 5 , STRAIN TIME HISTORY

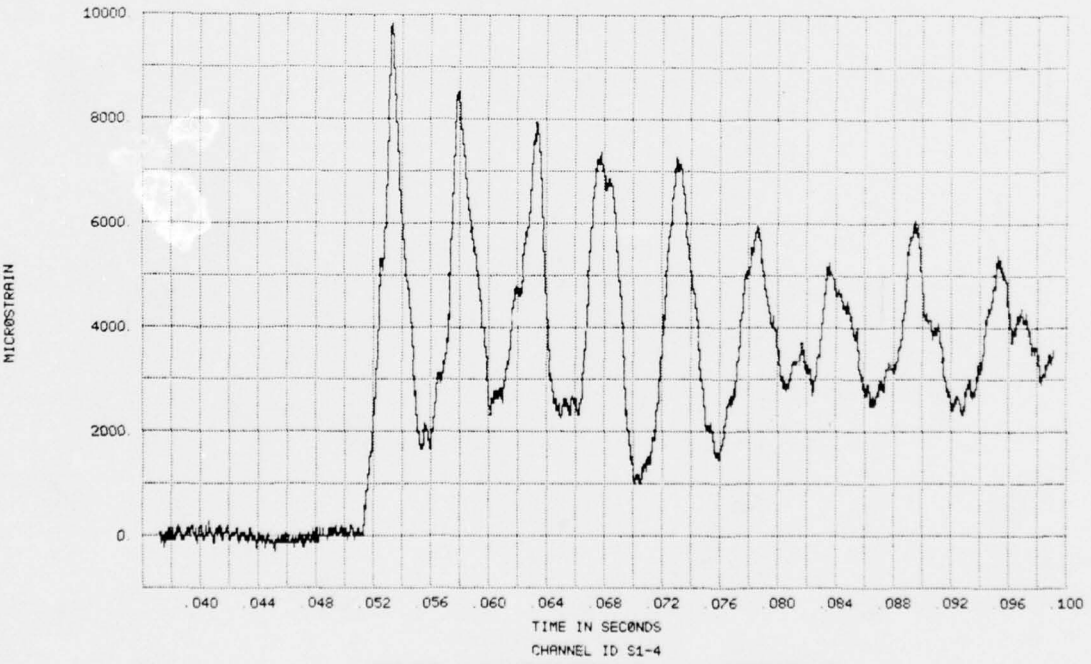


FIGURE 1-66 , SPECIMEN NO. 1 , SHOT NO. 5 , STRAIN TIME HISTORY

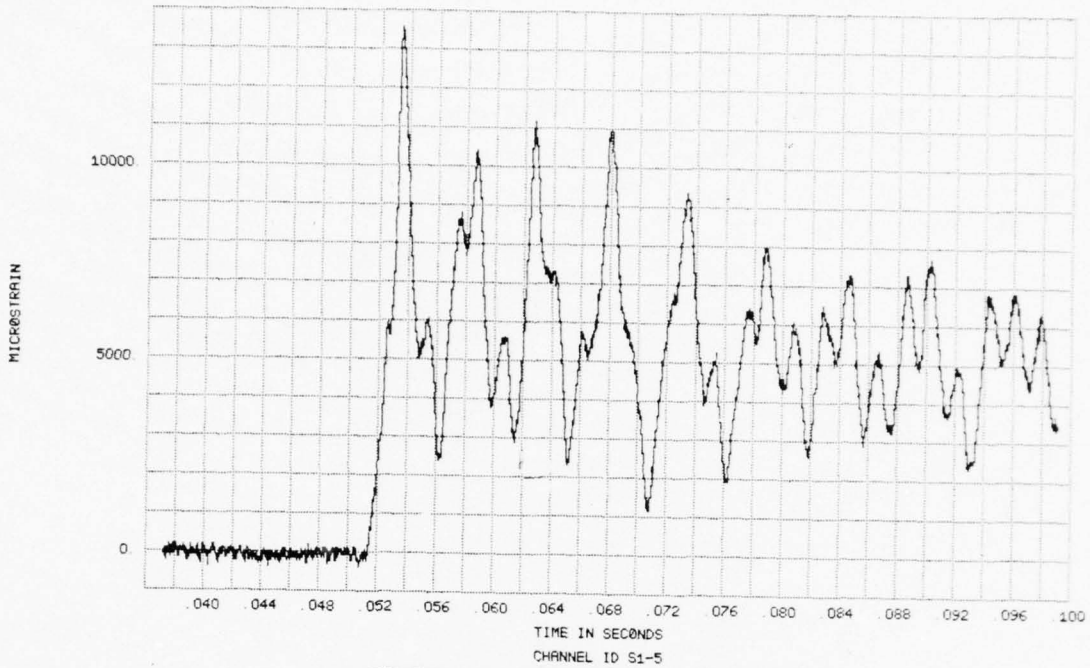


FIGURE 1-67 SPECIMEN NO. 1 , SHOT NO. 5 ,
STRAIN TIME HISTORY

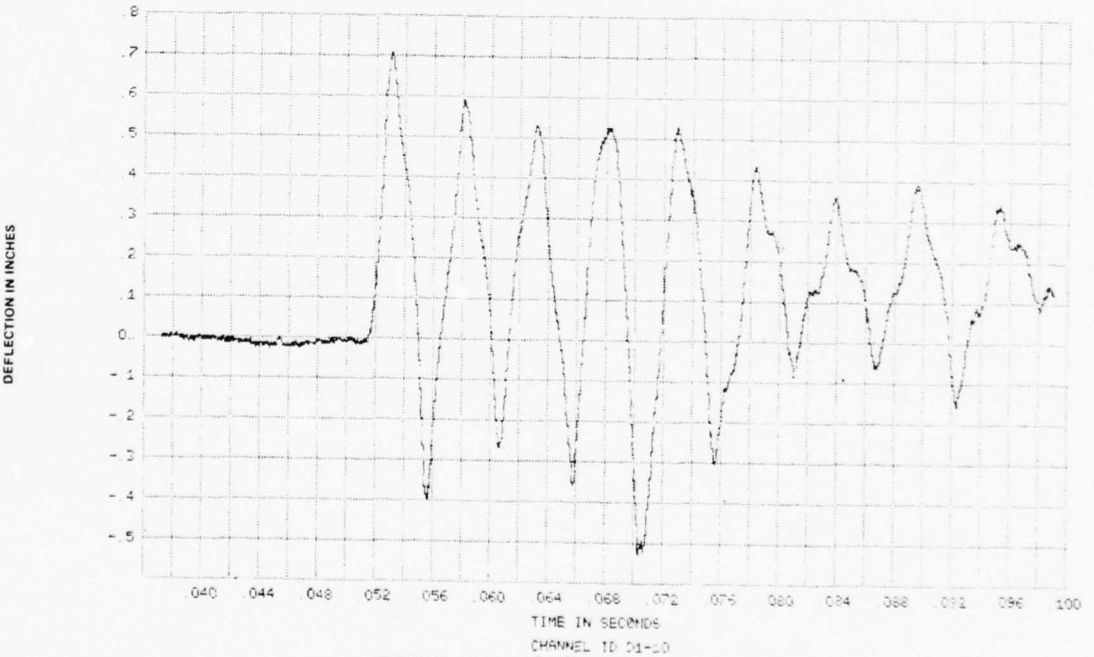
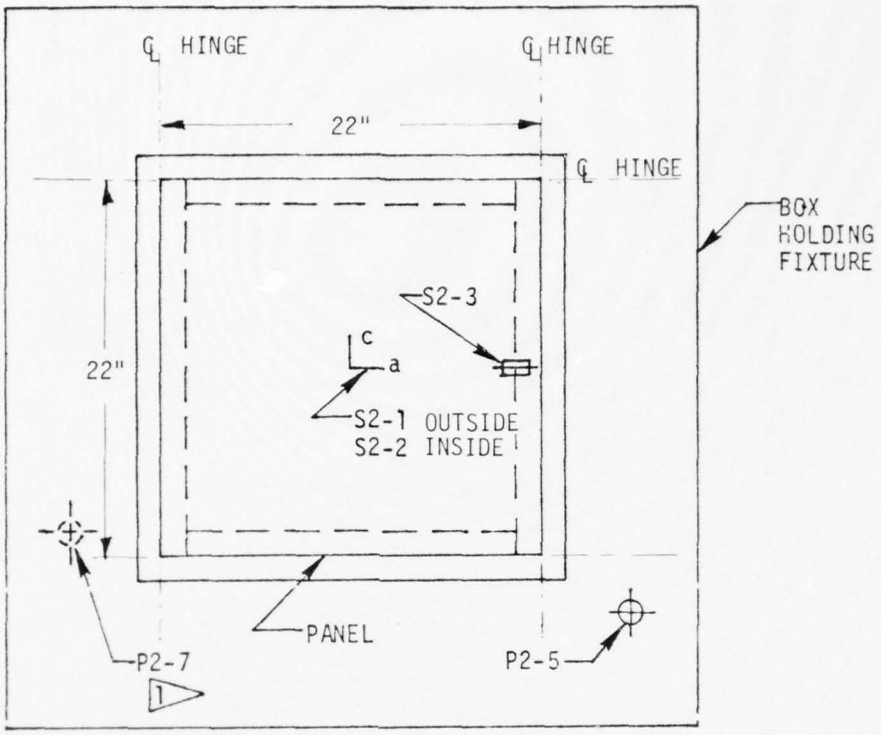


FIGURE 1-68 , SPECIMEN NO. 1 , SHOT NO. 5 ,
DEFLECTION TIME HISTORY



SPECIMEN NO. 2

FLAT UNSTIFFENED PANEL

FOUR SIDES PINNED

MATERIAL - 6061-T42 ALUMINUM ALLOY

DENSITY - .0002539 lb.-sec.^{2}/in^4 (MIL-HDBK-5)

POISSON'S RATIO - .33

MODULUS OF ELASTICITY - 10.4 x 10^6 PSI

SHEAR MODULUS - 3.8 x 10^6 PSI

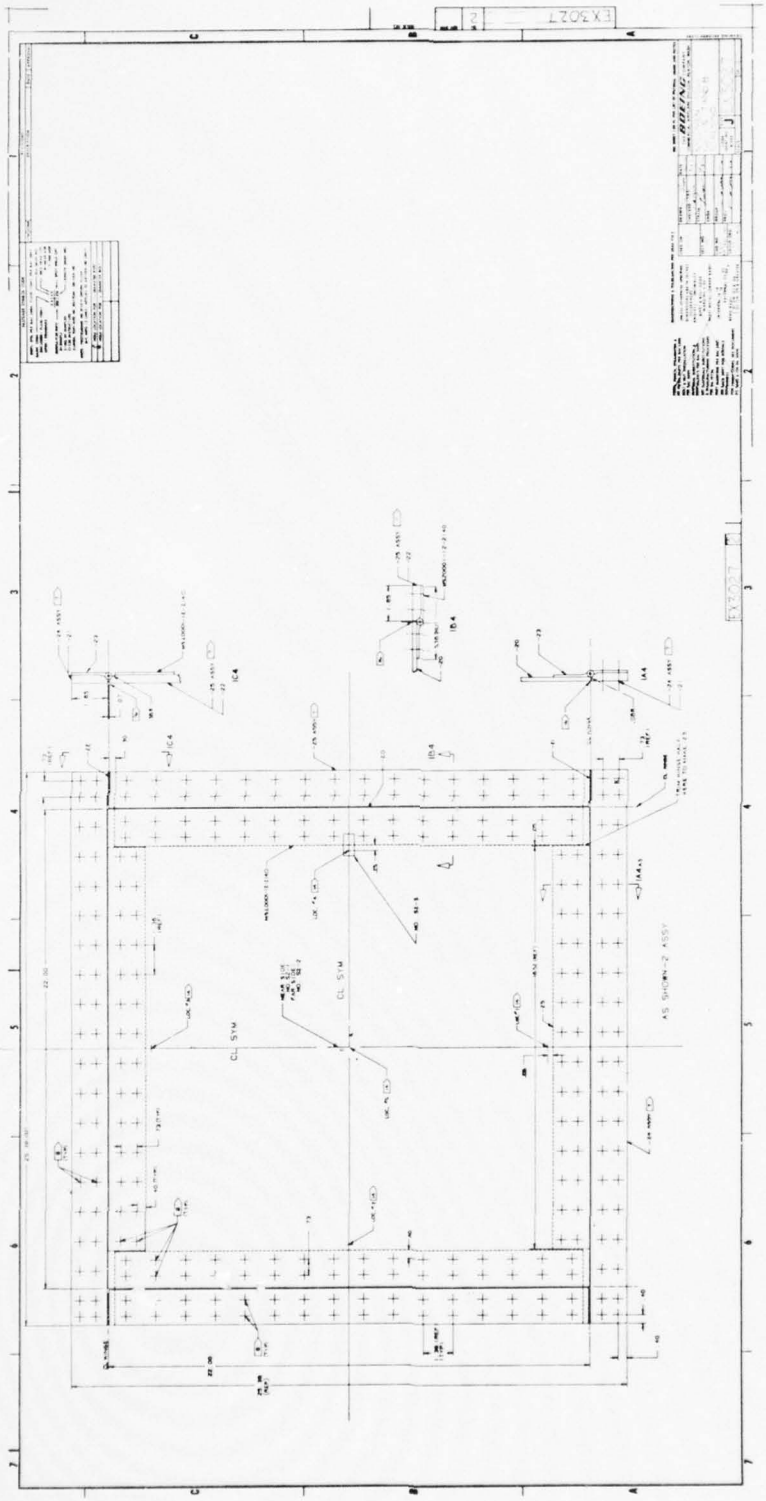
% ELONGATION - 25.5

F_{ty} = 18,410 PSI

F_{tu} = 36,090 PSI

THICKNESS - .192 IN.

1 ON BACK SIDE ON BOX HOLDING FITURE ONLY



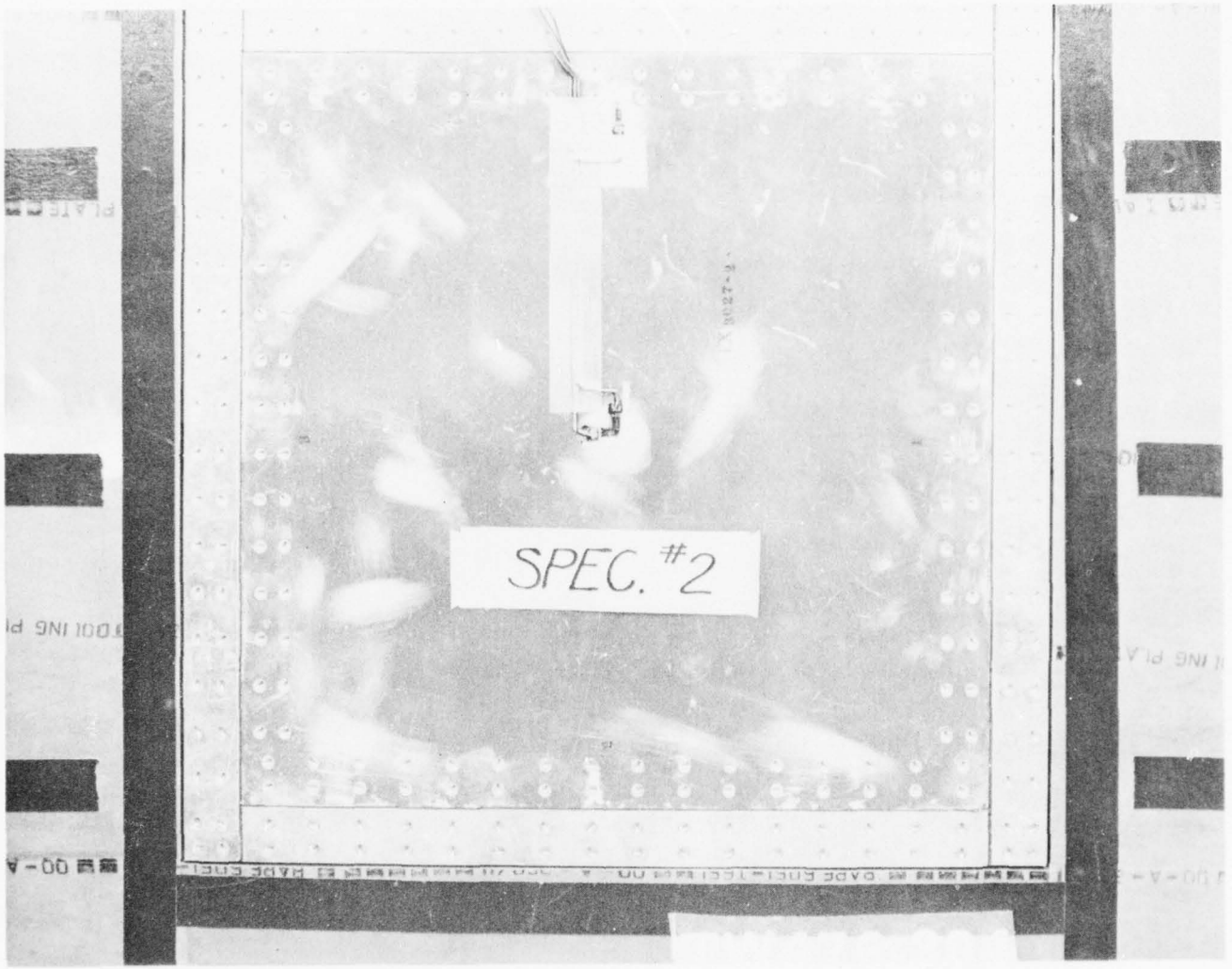


FIGURE 2-1 - SPECIMEN NO. 2 - INSTRUMENTATION - FRONT

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.2 - STATIC ANALYSIS - PRESS = 5.0 PSI - MAY'76 - SYRING  GP   1
           1              0                                               GP   2
0.0         0.1            0.01          0.0                             GP   3
0.0         0.0            0.0           0.0                             GP   4
          15             15                                              GP   5
100000.                                                                  GP   7
                                                                         GP   8
           2              0                                               GP   9
           2                                                              GP  10
           0              0                                               GP  12
           0              0                                               GP  15
           2              2                                               GP  16
0.0         0.0                                                          GP  17
0.0         42.0                                                         GP  17
-42.0       0.0                                                          GP  20
-42.0       42.0                                                         GP  20
           0                                                             GP  21
           4              1             1                               GP  25
-21.0       0.0            21.0                                         GP  26
-5.0                                                                     GP  30
           5              5             11            11                GPP   1
           0              2             1                               GPP   2
          10                                                             GPP   3
           2              5                                             GPP   4
           3              4                                             GPP   4
           3              3                                             GPP   4
           4              3                                             GPP   4
           4              4                                             GPP   4
           4              5                                             GPP   4
           5              2                                             GPP   4
           5              3                                             GPP   4
           5              4                                             GPP   4
           5              5                                             GPP   4
           1                                                            GPP   5
22.0        22.0                                                         GPP   6
0.192       .0002539                                                     GPP   7
10400000.   10400000.      0.33          0.33          3800000.         GPP   8
18410.      18410.                                                       GPP   9
0.0         0.0            0.0           0.0           0.0       0.0     GPP  13
0.0         0.0            0.0           0.0           0.0       0.0     GPP  13
0.0         0.0            0.0           0.0           0.0       0.0     GPP  13
0.0         0.0            0.0           0.0           0.0       0.0     GPP  13
0.0                                                                      GPP  13
.000001     .000001        1.0                                           GPP  14
                                                                         GP  32
```

TABLE XXIII

STATIC TEST STRESSES - SPECIMEN NO. 2
(STRESSES GIVEN IN PSI)

STRAIN GAUGE	STATIC PRESSURE (PSI)				
	2.4	4.8	6.0	7.2	8.0
S2-1	-4157.	-5331.	-5431.	-5462.	-5393.
S2-2	5712.	9540.	10949.	12100.	12807.
S2-3	-1260.	-3151.	-4213.	-5334.	-5357.

TABLE XXIV

STATIC TEST DISPLACEMENTS - SPECIMEN NO. 2
(DISPLACEMENT MEASURED AT CENTER OF PANEL)

	STATIC PRESSURE (PSI)				
	2.4	4.8	6.0	7.2	8.0
DISPLACEMENT (INCHES)	.203	.334	.386	.431	.459



FIGURE 2-2 - SPECIMEN NO. 2 - SHOCK TEST SET-UP



FIGURE 2-3 - SPECIMEN NO. 2 - DEFORMED SPECIMEN AFTER SHOCK TEST



FIGURE 2-4 - SPECIMEN NO. 2 - INDICATION OF SHOCK TEST PERMANENT DEFORMATION

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.2 -DYNAMIC ANALYSIS - ITERATIVE TPD SOLUTION                    GP  1
          1          0                                                           GP  2
5000.      0.001      0.02       0.0                                            GP  3
0.0        0.0        0.0        0.0                                            GP  4
         15         15                                                          GP  5
500.                                                                            GP  7
                                                                                GP  8
          2          0                                                          GP  9
          0          1                                                          GP 10
0.5                                                                             GP 11
          0          0                                                          GP 12
          0          0                                                          GP 13
          2          2                                                          GP 14
48.0       0.0                                                                  GP 15
20.0      96.0                                                                  GP 16
-60.0      0.0                                                                  GP 17
-70.0     96.0                                                                  GP 18
          0                                                                     GP 21
          4          1                                                          GP 25
-21.0      0.0       21.0                                                       GP 26
                                                                                GP 30
          5          5         11         11          5                       GPP  1
          0          2          1                                              GPP  2
         10                                                                     GPP  3
          2          5                                                          GPP  4
          3          4                                                          GPP  4
          3          5                                                          GPP  4
          4          3                                                          GPP  4
          4          4                                                          GPP  4
          4          5                                                          GPP  4
          5          2                                                          GPP  4
          5          3                                                          GPP  4
          5          4                                                          GPP  4
          5          5                                                          GPP  4
          1                                                                     GPP  5
22.0      22.0                                                                  GPP  6
0.192     .0002539                                                              GPP  7
10400000. 10400000.    0.33       0.33       3800000.                         GPP  8
18410.    18410.                                                              GPP  9
0.0       0.0        0.0        0.0        0.0        0.0                      GPP 12
0.0       0.0        0.0        0.0        0.0        0.0                      GPP 13
0.0       0.0        0.0        0.0        0.0        0.0                      GPP 13
0.0       0.0        0.0        0.0        0.0        0.0                      GPP 13
0.0                                                                             GPP 13
0.0       0.010     25.0                                                       GPP 14
                                                                                GP  32
```

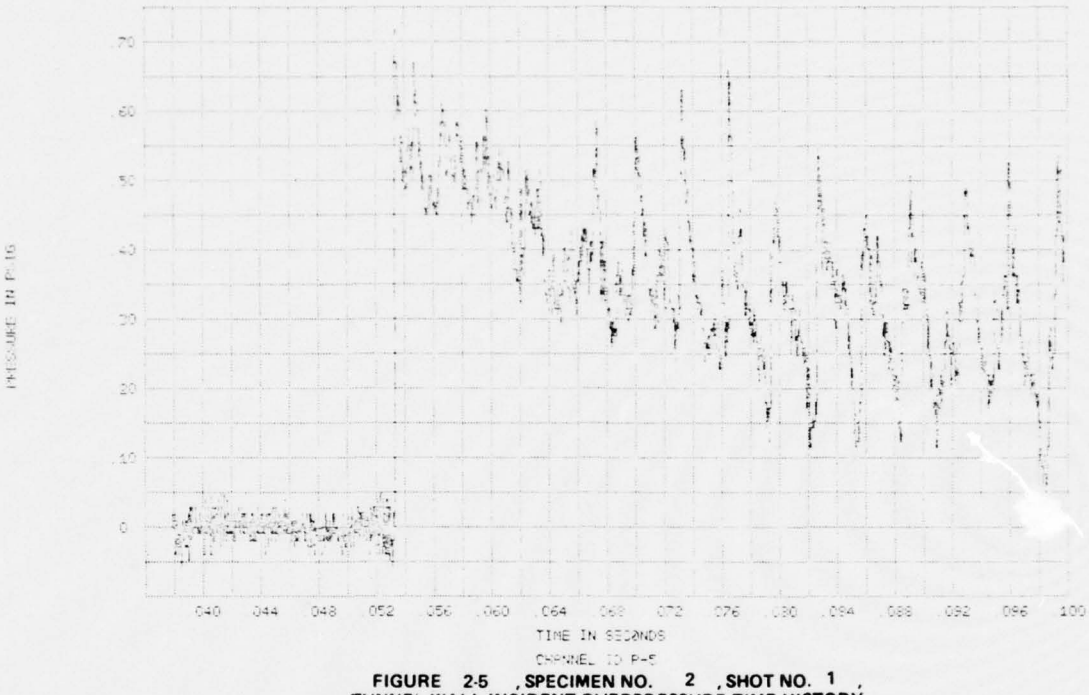


FIGURE 2-5 , SPECIMEN NO. 2 , SHOT NO. 1 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

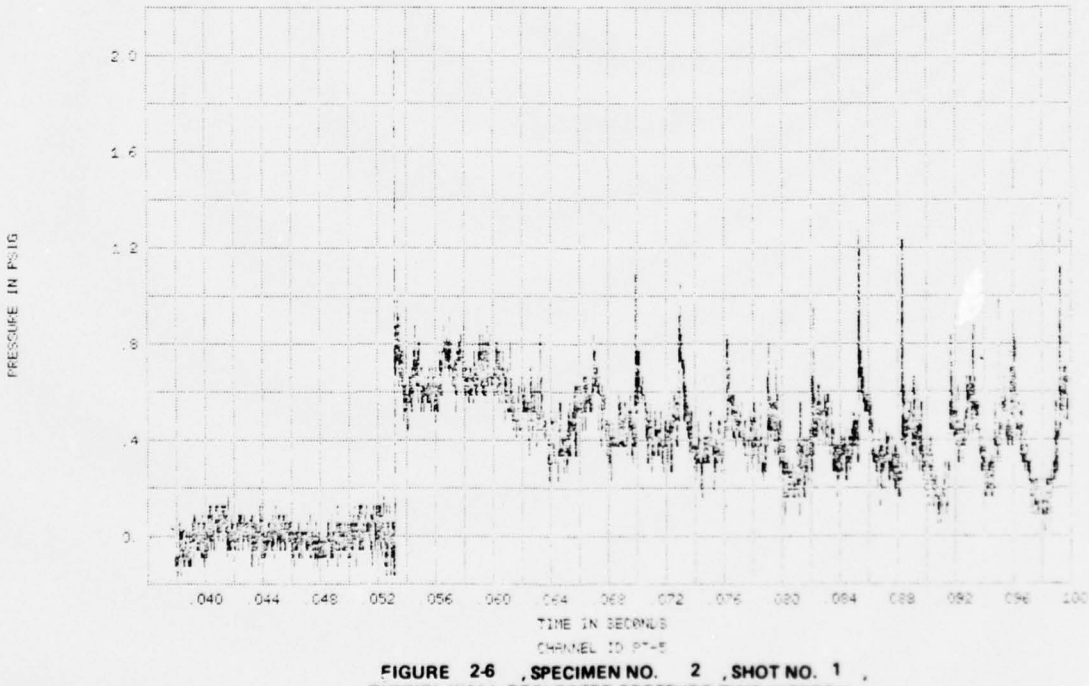


FIGURE 2-6 , SPECIMEN NO. 2 , SHOT NO. 1 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

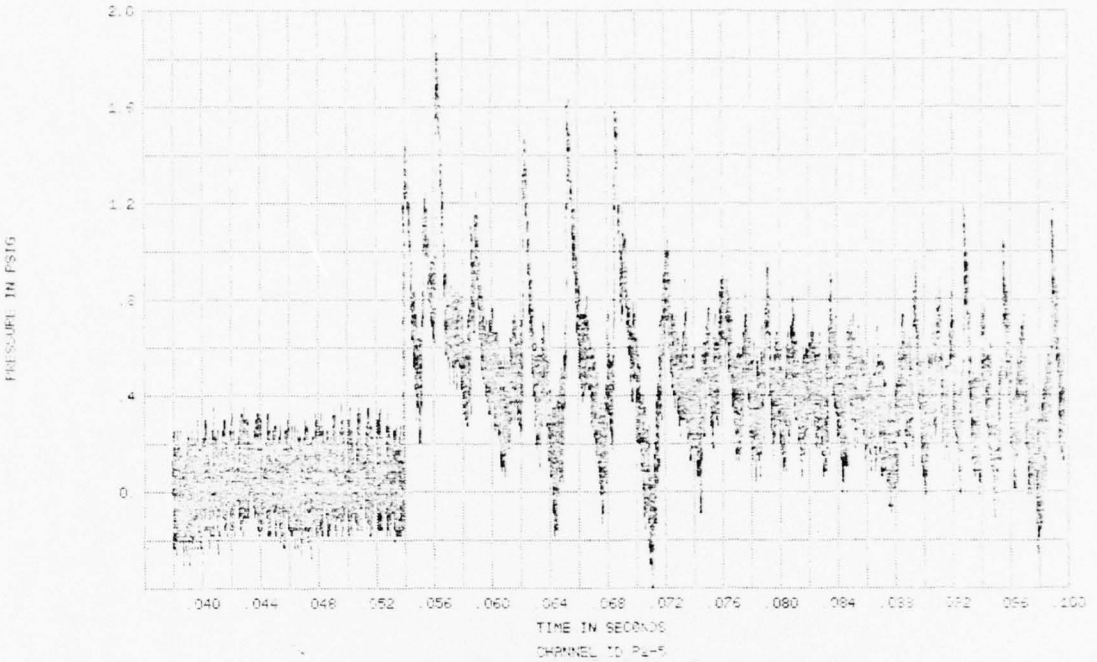


FIGURE 2-7 SPECIMEN NO. 2 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

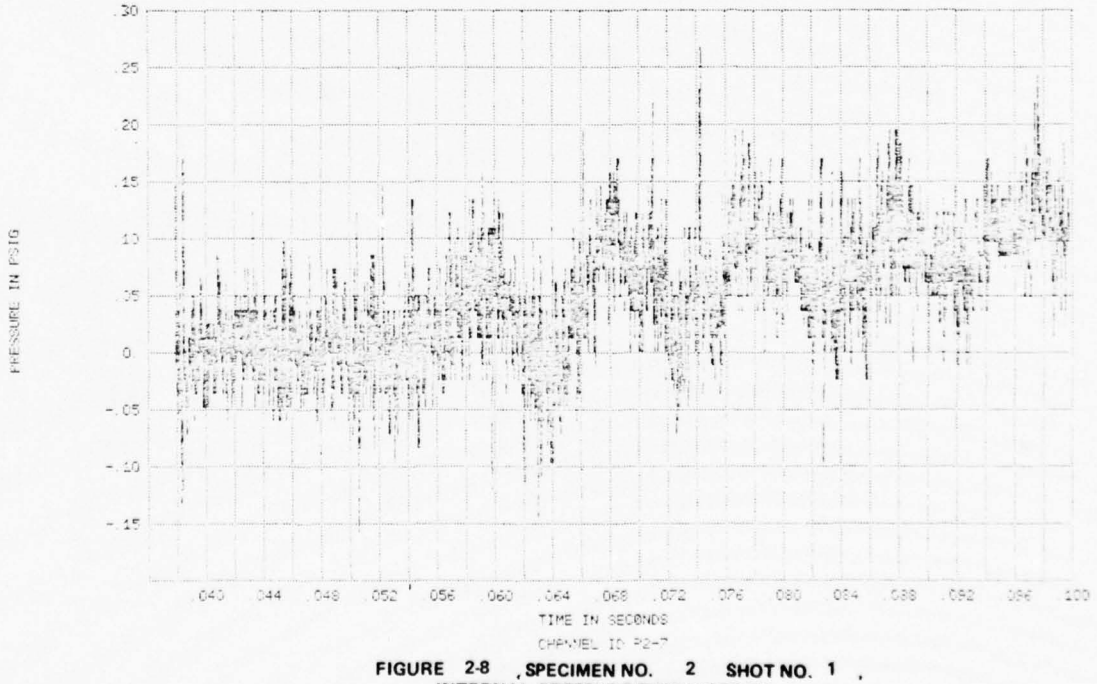


FIGURE 2-8 , SPECIMEN NO. 2 SHOT NO. 1 ,
INTERNAL PRESSURE TIME HISTORY

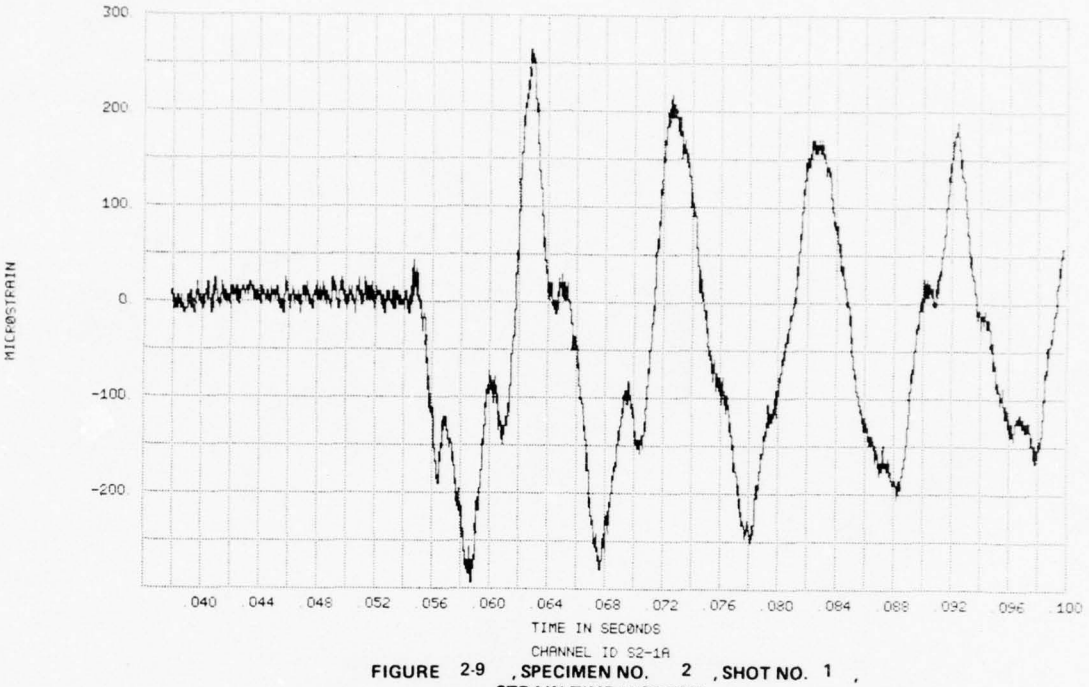


FIGURE 2-9 , SPECIMEN NO. 2 , SHOT NO. 1 ,
STRAIN TIME HISTORY

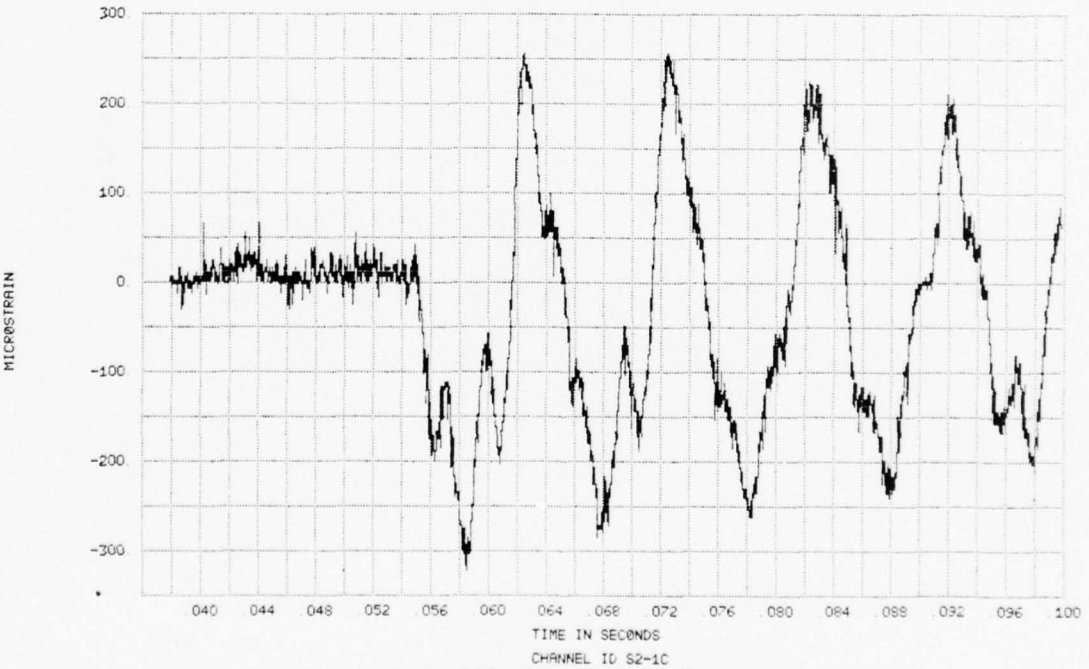


FIGURE 2-10 , SPECIMEN NO. 2 , SHOT NO. 1 ,
STRAIN TIME HISTORY

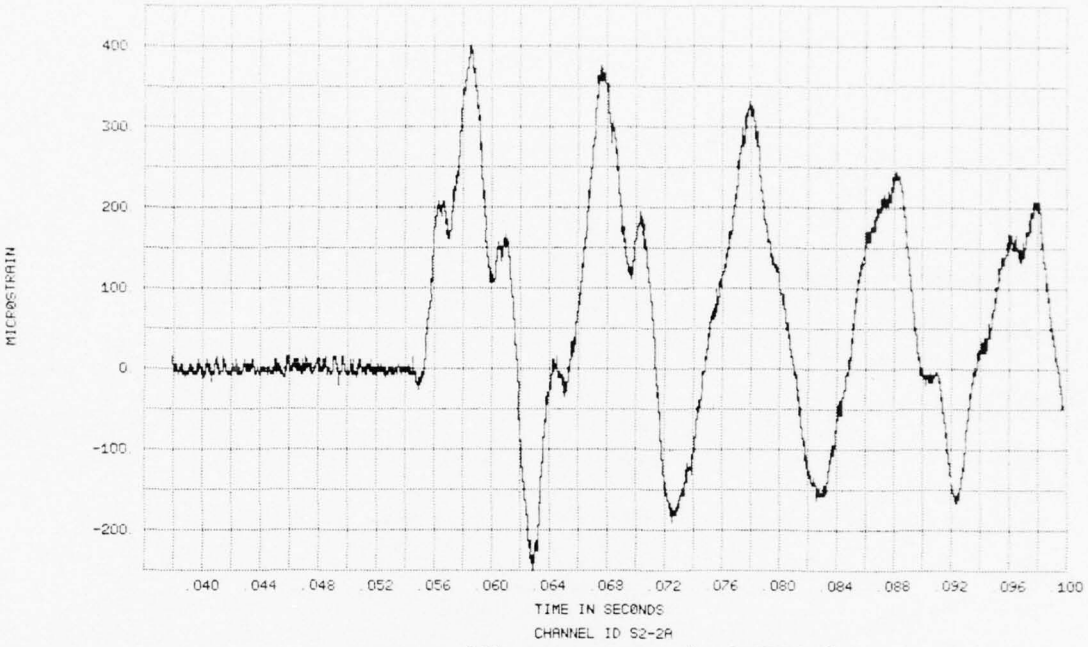


FIGURE 2-11 , SPECIMEN NO. 2 , SHOT NO. 1 ,
STRAIN TIME HISTORY

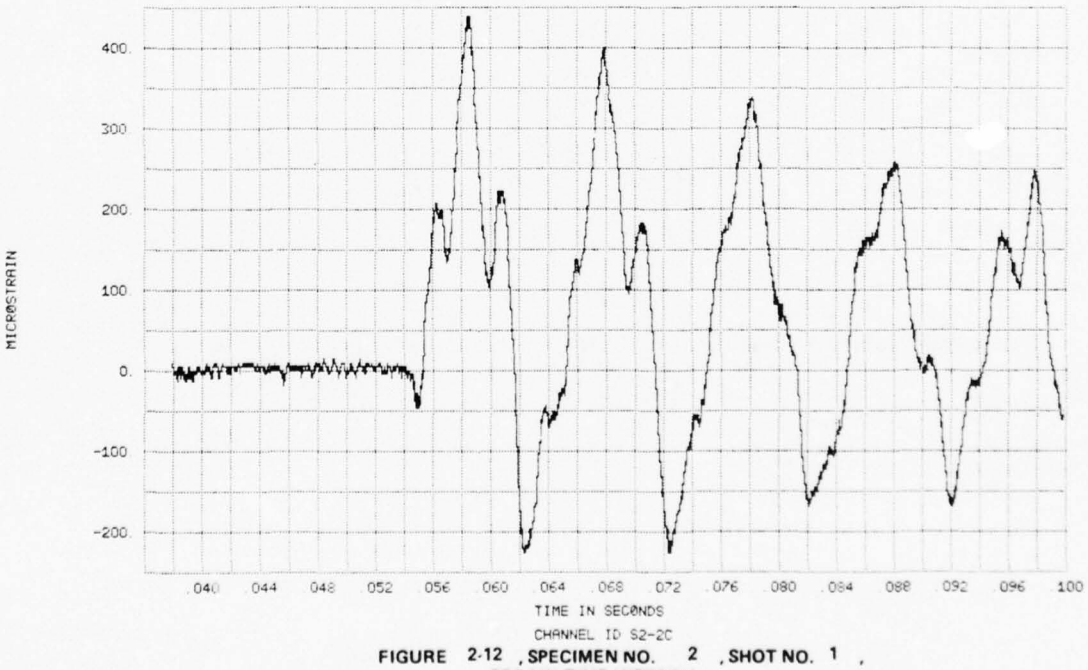


FIGURE 2-12 , SPECIMEN NO. 2 , SHOT NO. 1 ,
STRAIN TIME HISTORY

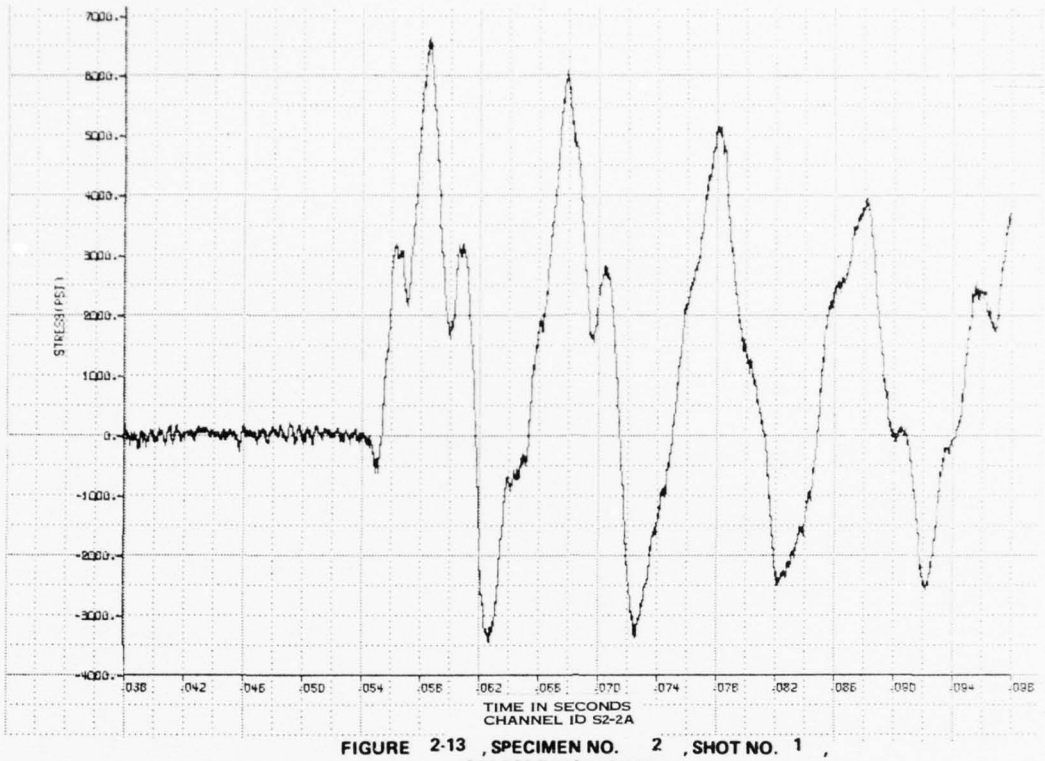


FIGURE 2-13 , SPECIMEN NO. 2 , SHOT NO. 1 ,
STRESS TIME HISTORY

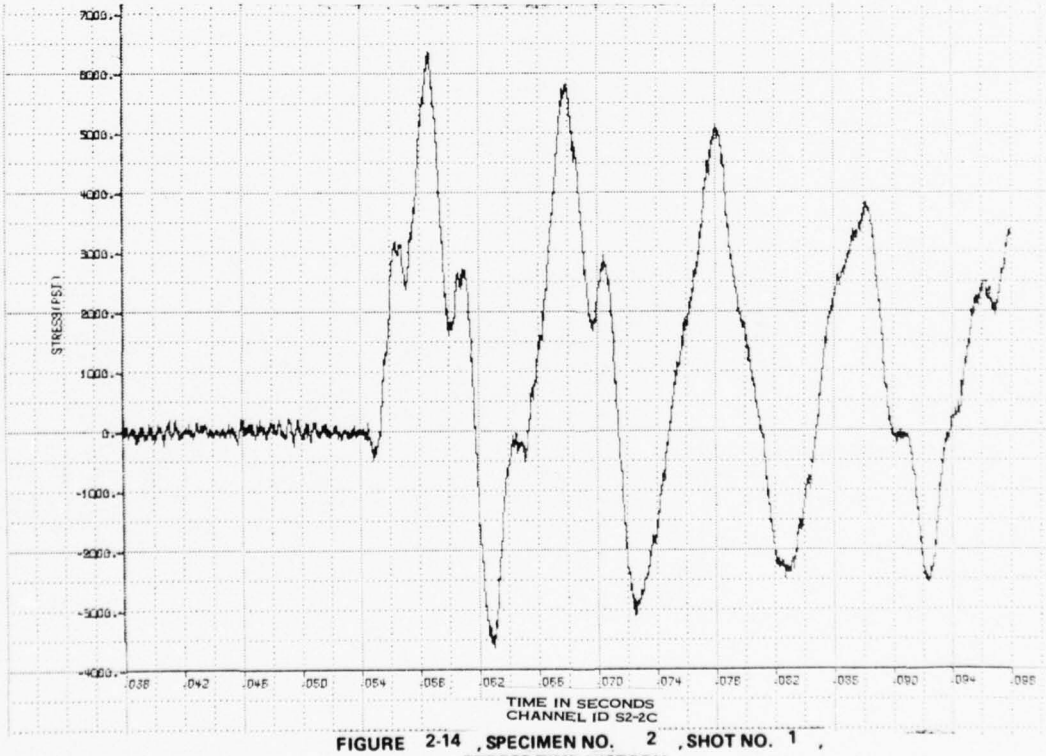


FIGURE 2-14 , SPECIMEN NO. 2 , SHOT NO. 1 ,
STRESS TIME HISTORY

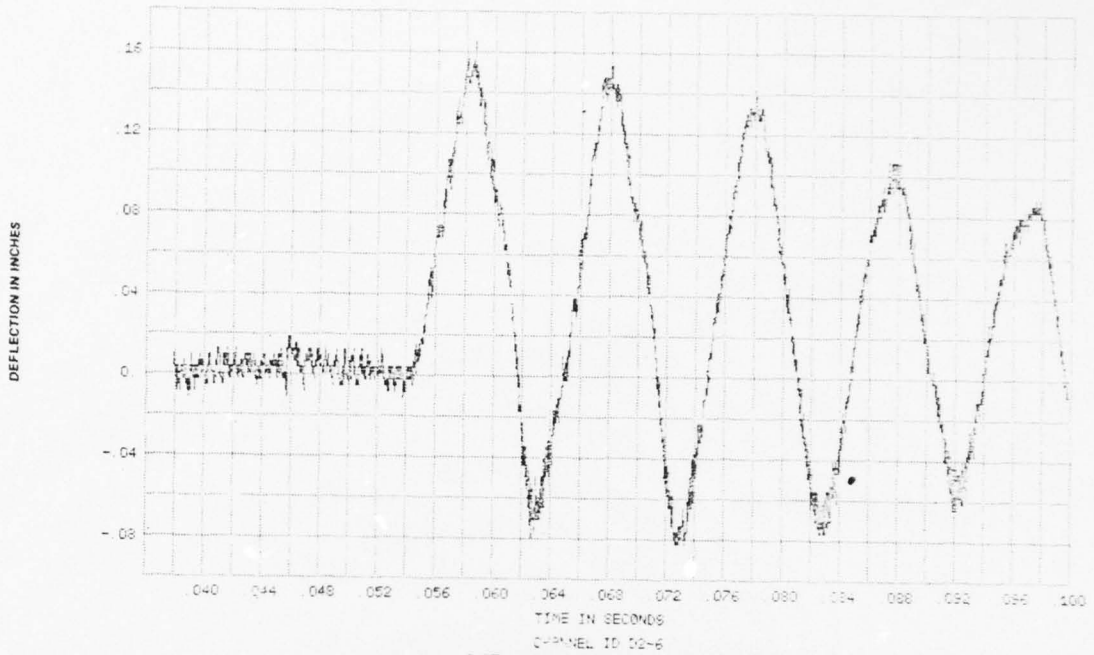


FIGURE 2-15 , SPECIMEN NO. 2 , SHOT NO. 1 ,
DEFLECTION TIME HISTORY

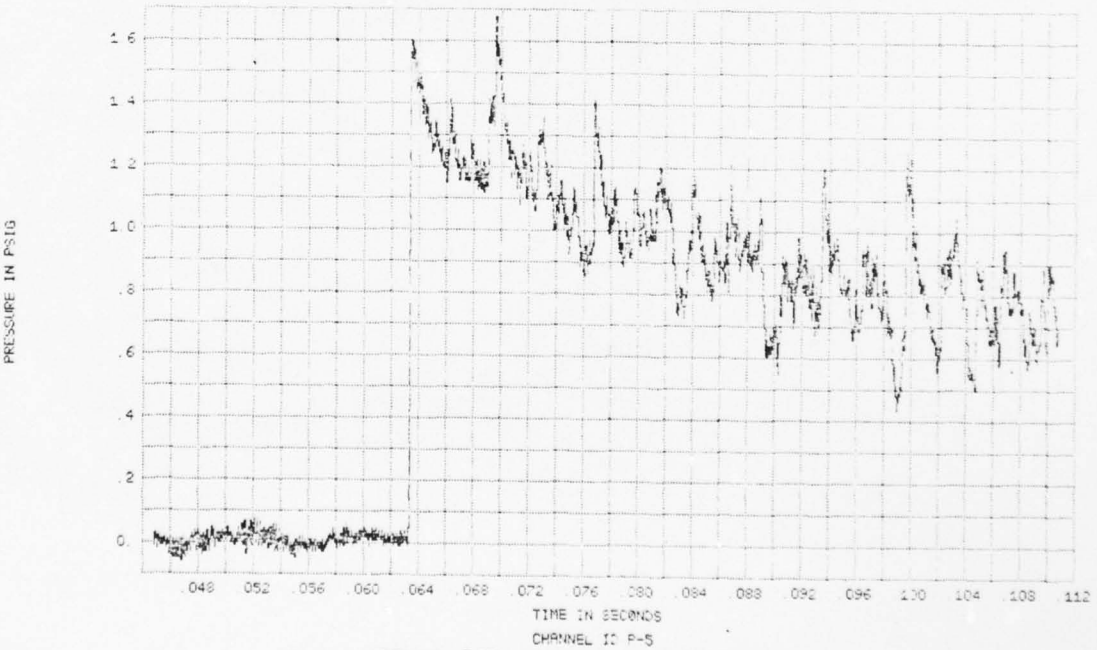


FIGURE 2-16 , SPECIMEN NO. 2 , SHOT NO. 2 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

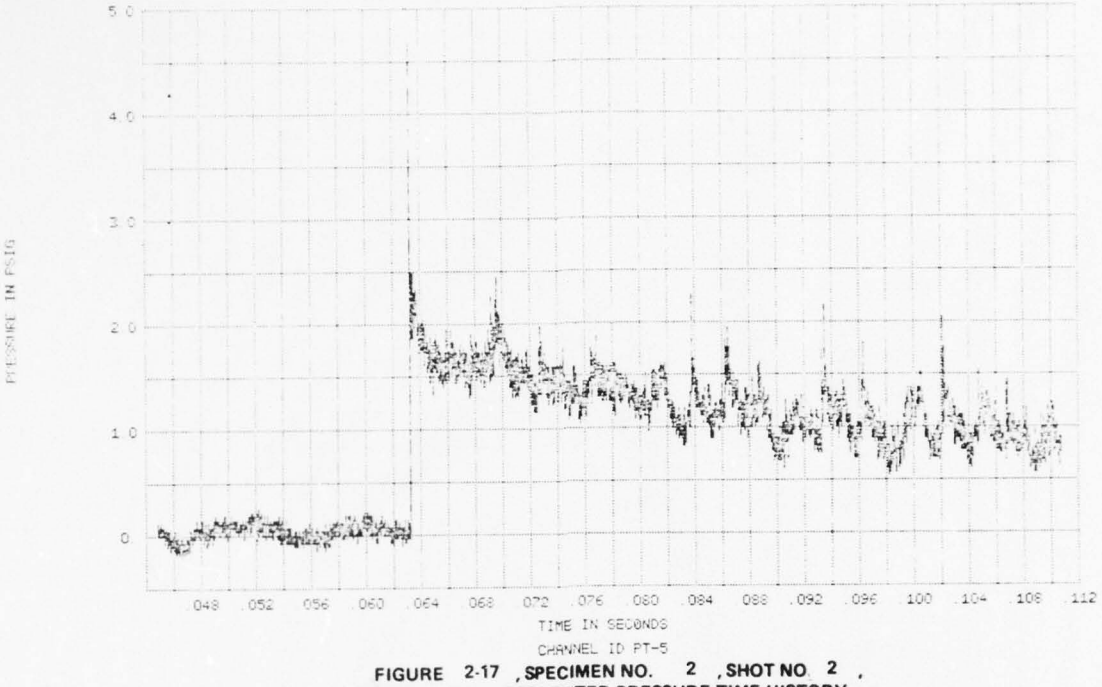


FIGURE 2-17 , SPECIMEN NO. 2 , SHOT NO. 2 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

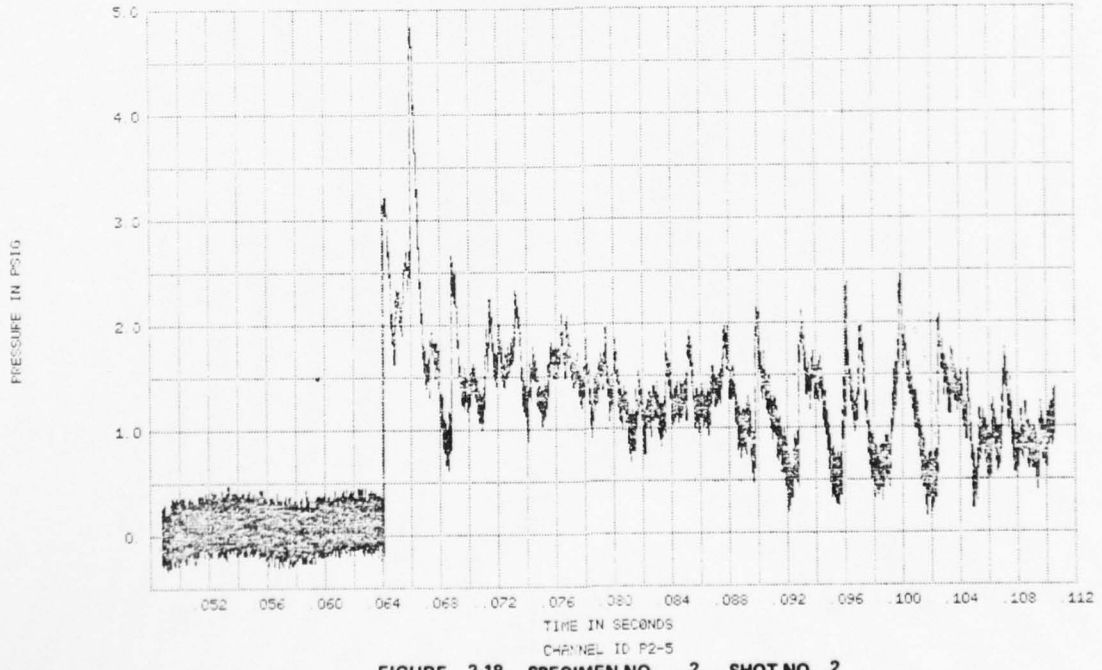


FIGURE 2-18 , SPECIMEN NO. 2 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

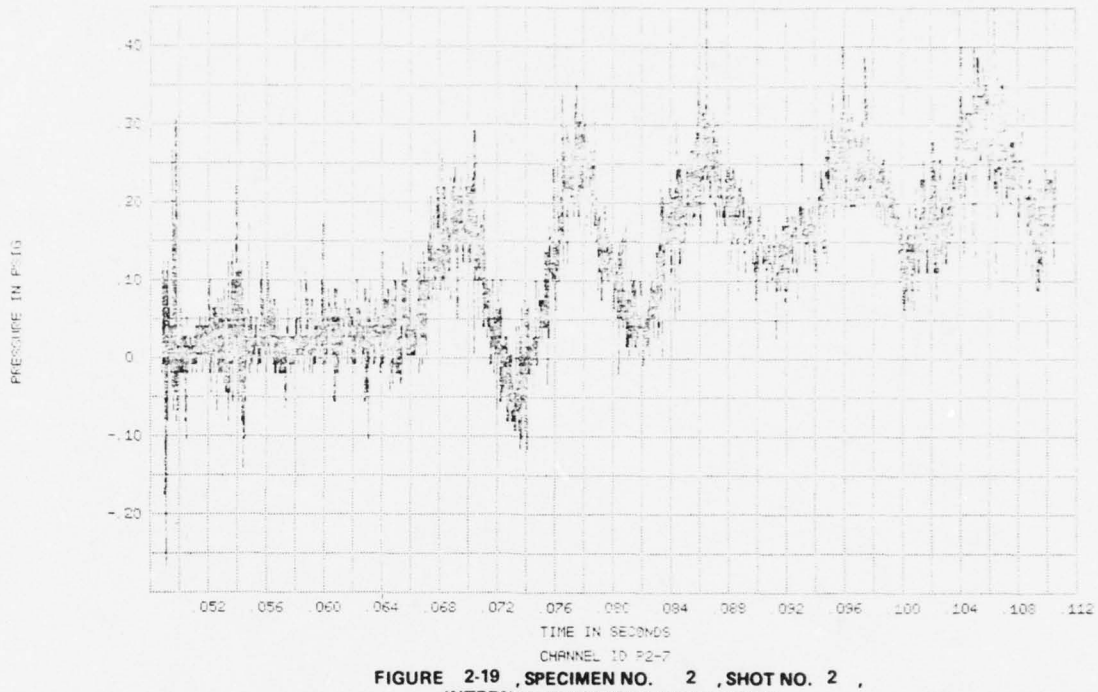


FIGURE 2-19 , SPECIMEN NO. 2 , SHOT NO. 2 ,
INTERNAL PRESSURE TIME HISTORY

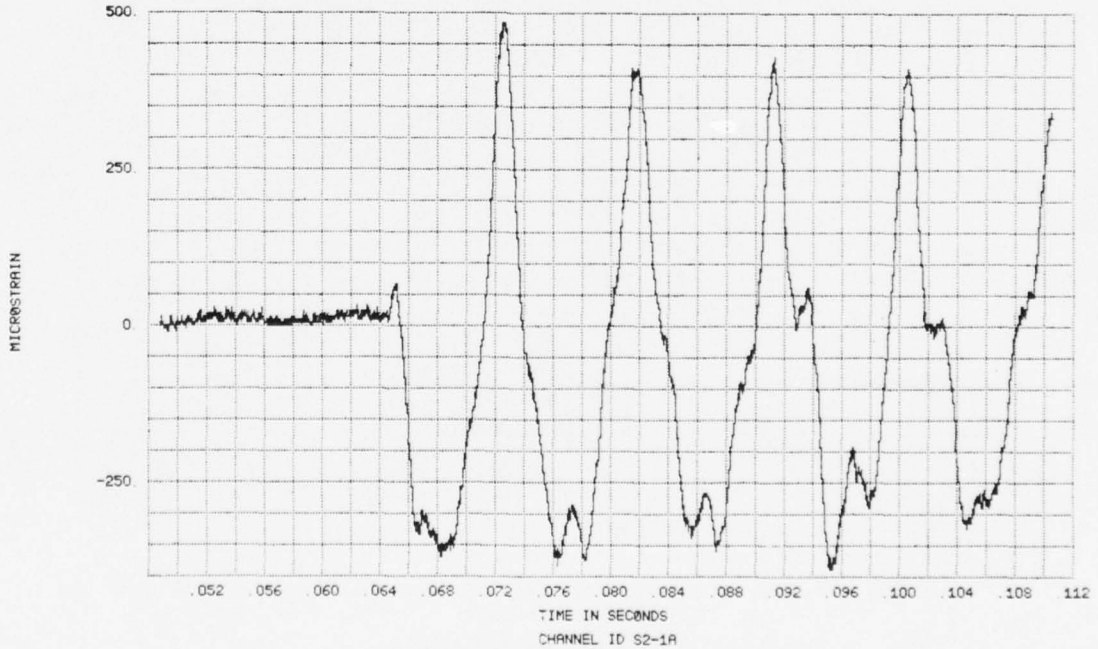


FIGURE 2-20 , SPECIMEN NO. 2 , SHOT NO. 2 ,
STRAIN TIME HISTORY

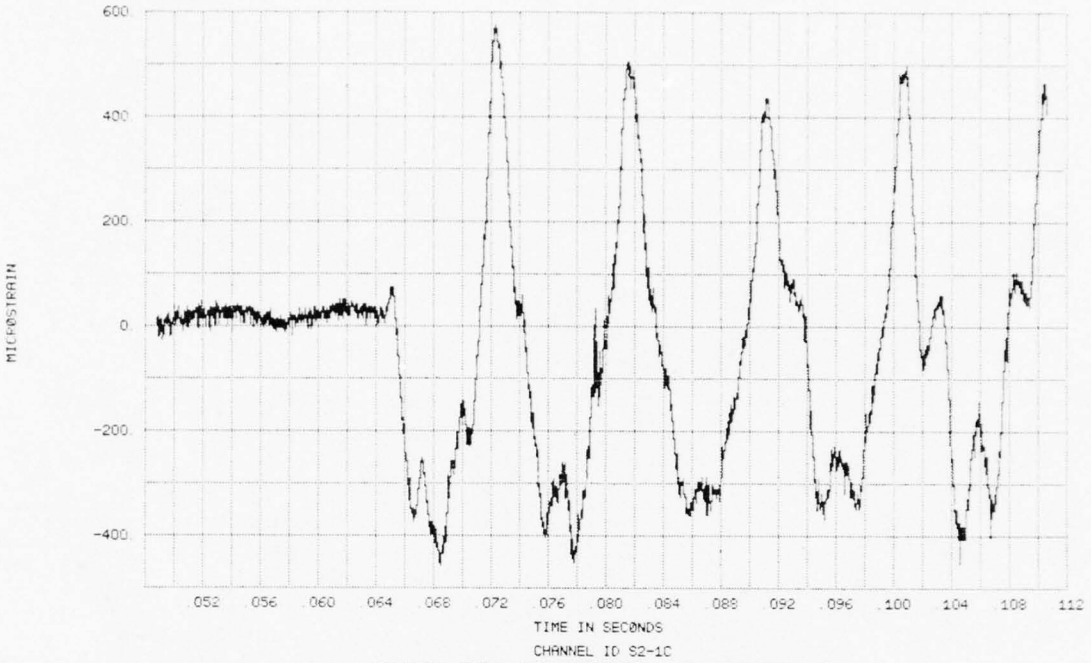


FIGURE 2-21 , SPECIMEN NO. 2 , SHOT NO. 2 ,
STRAIN TIME HISTORY

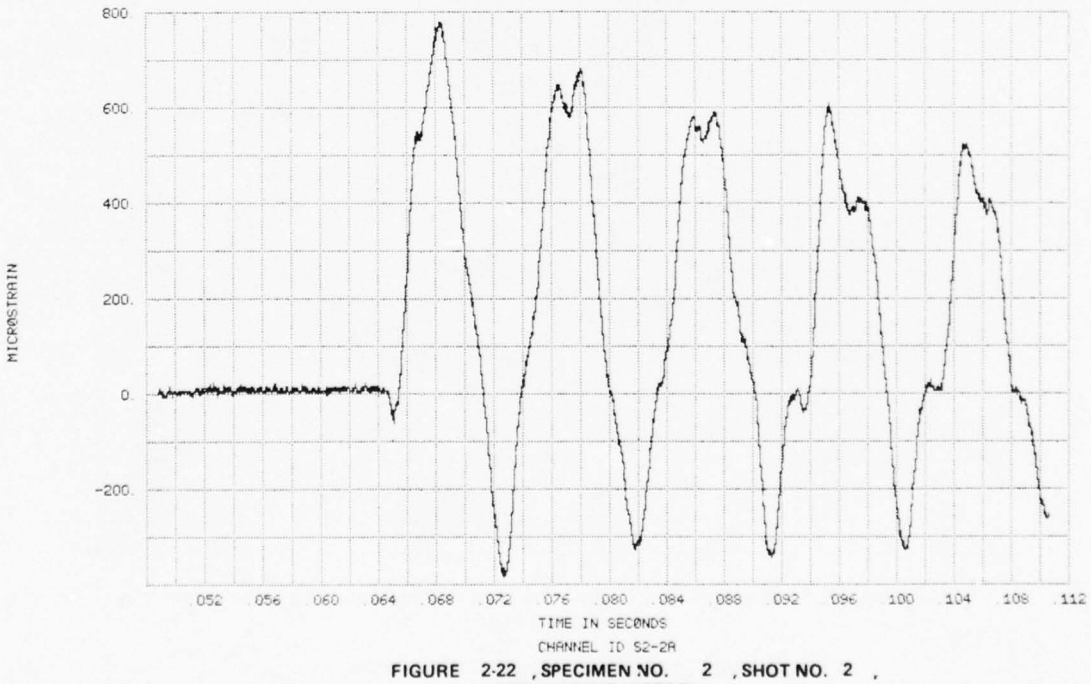


FIGURE 2-22 , SPECIMEN NO. 2 , SHOT NO. 2 ,
STRAIN TIME HISTORY

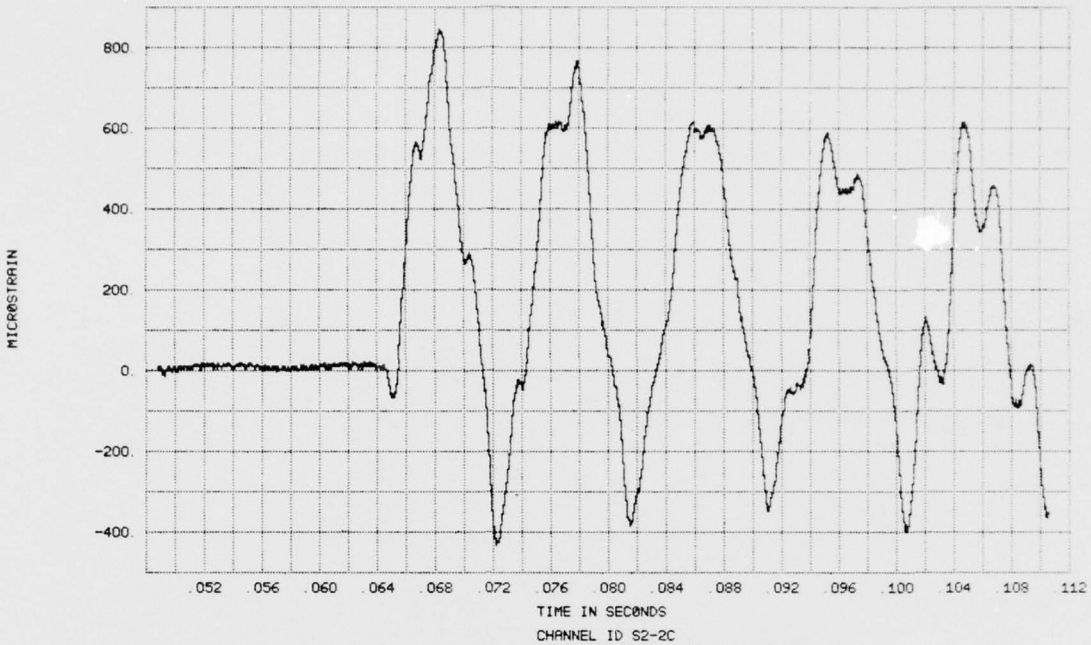


FIGURE 2-23 , SPECIMEN NO. 2 , SHOT NO. 2 ,
STRAIN TIME HISTORY

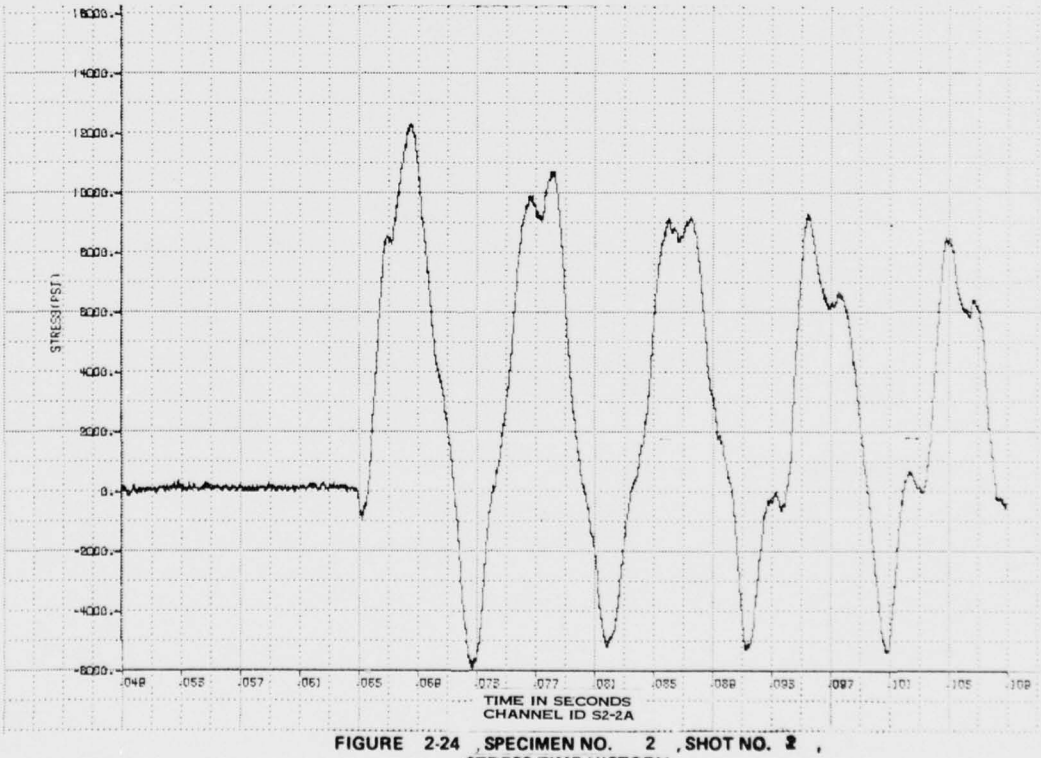


FIGURE 2-24 , SPECIMEN NO. 2 , SHOT NO. 2 ,
STRESS TIME HISTORY

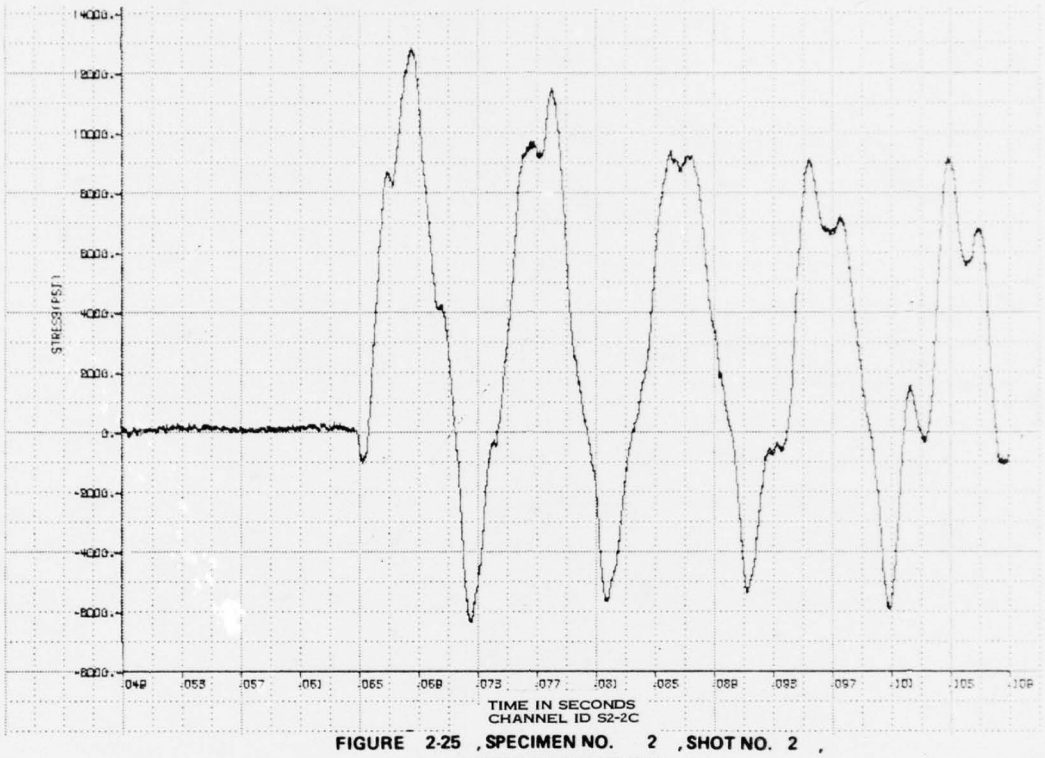


FIGURE 2-25 , SPECIMEN NO. 2 , SHOT NO. 2 ,
STRESS TIME HISTORY

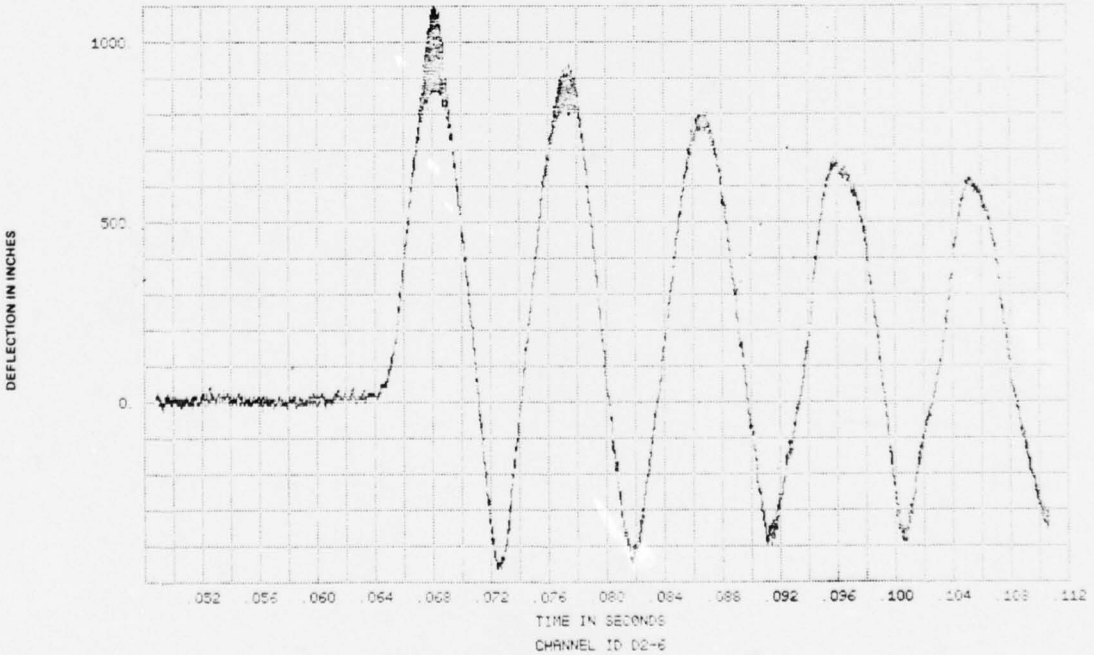


FIGURE 2-26 , SPECIMEN NO. 2 , SHOT NO. 2 ,
DEFLECTION TIME HISTORY

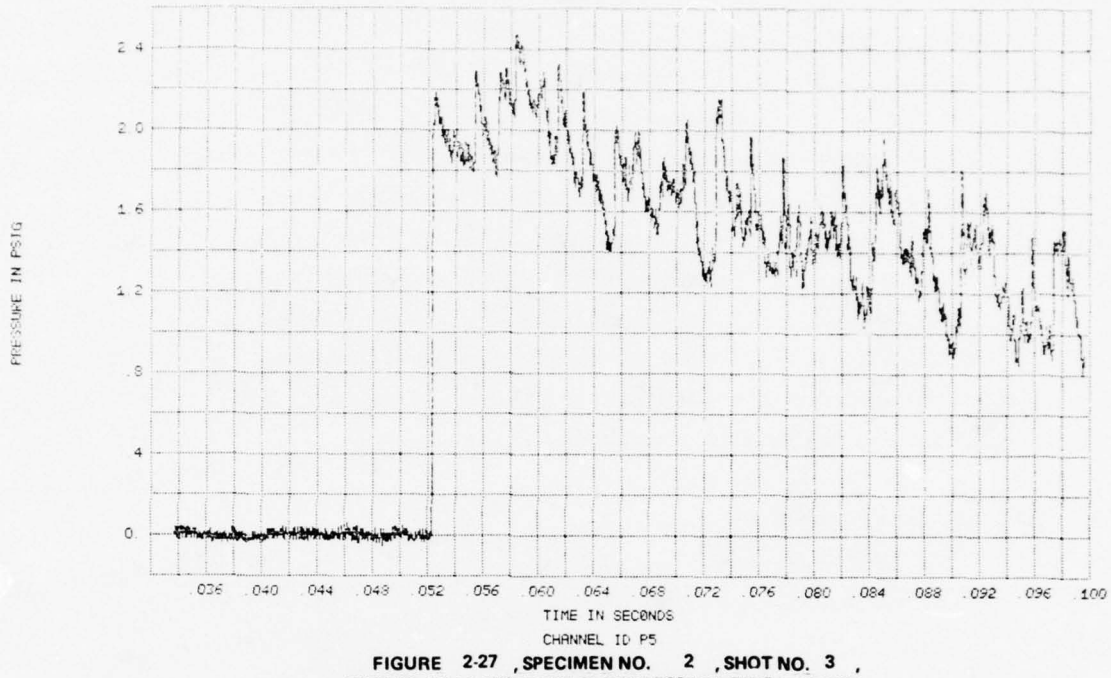


FIGURE 2-27 , SPECIMEN NO. 2 , SHOT NO. 3 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

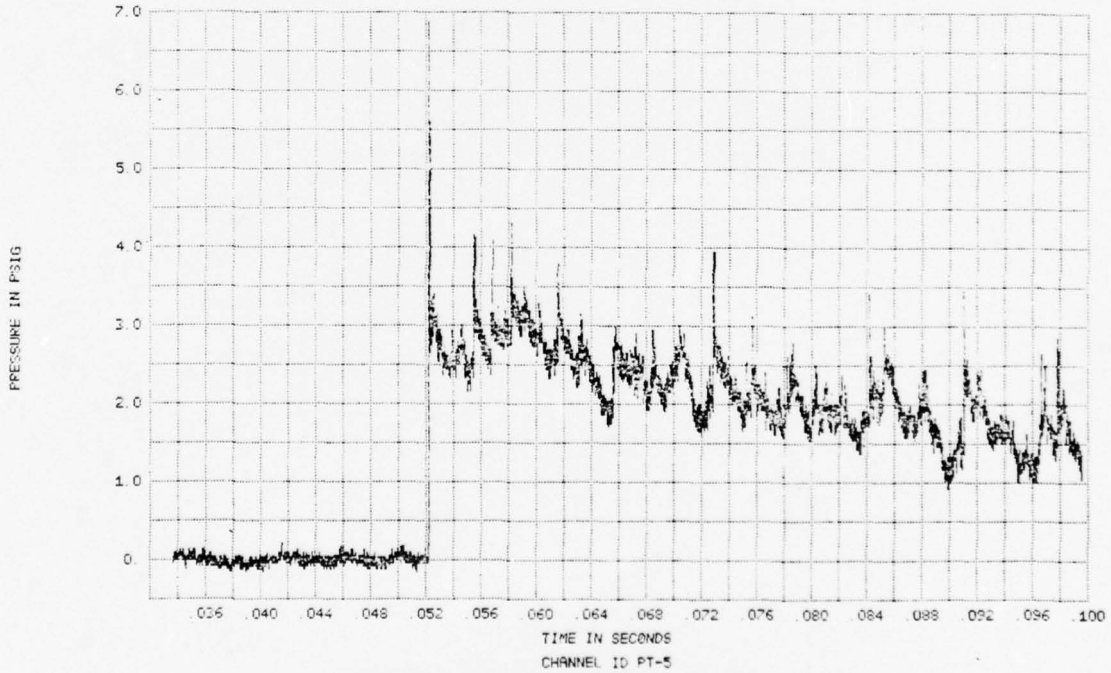


FIGURE 2-28 , SPECIMEN NO. 2 , SHOT NO. 3 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

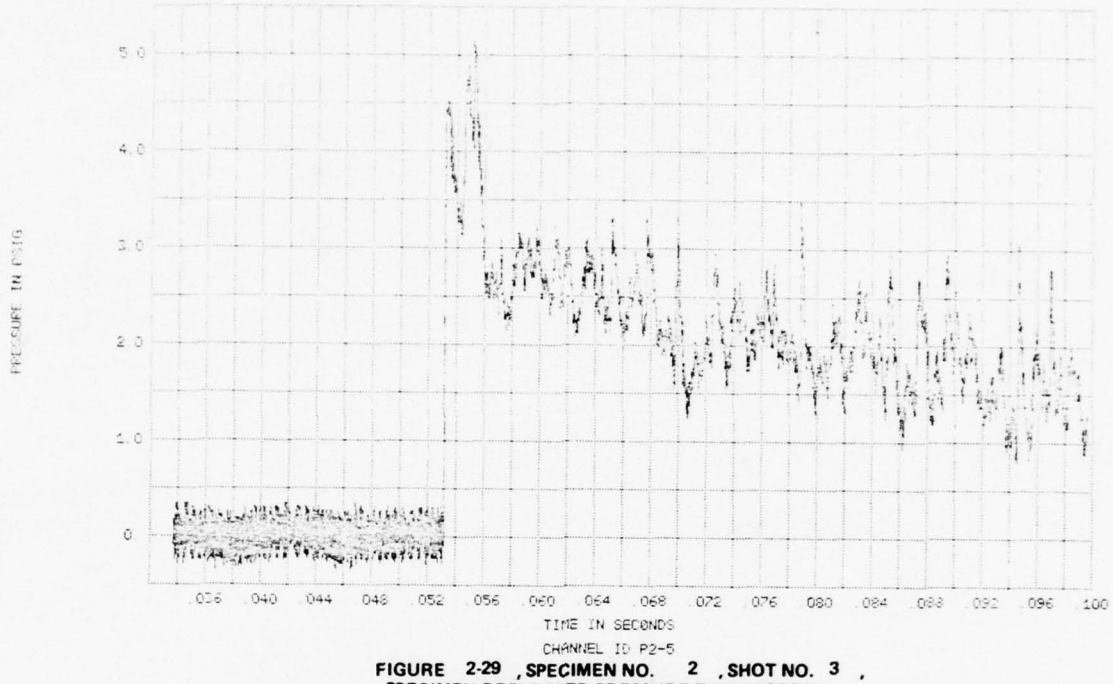


FIGURE 2-29 , SPECIMEN NO. 2 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

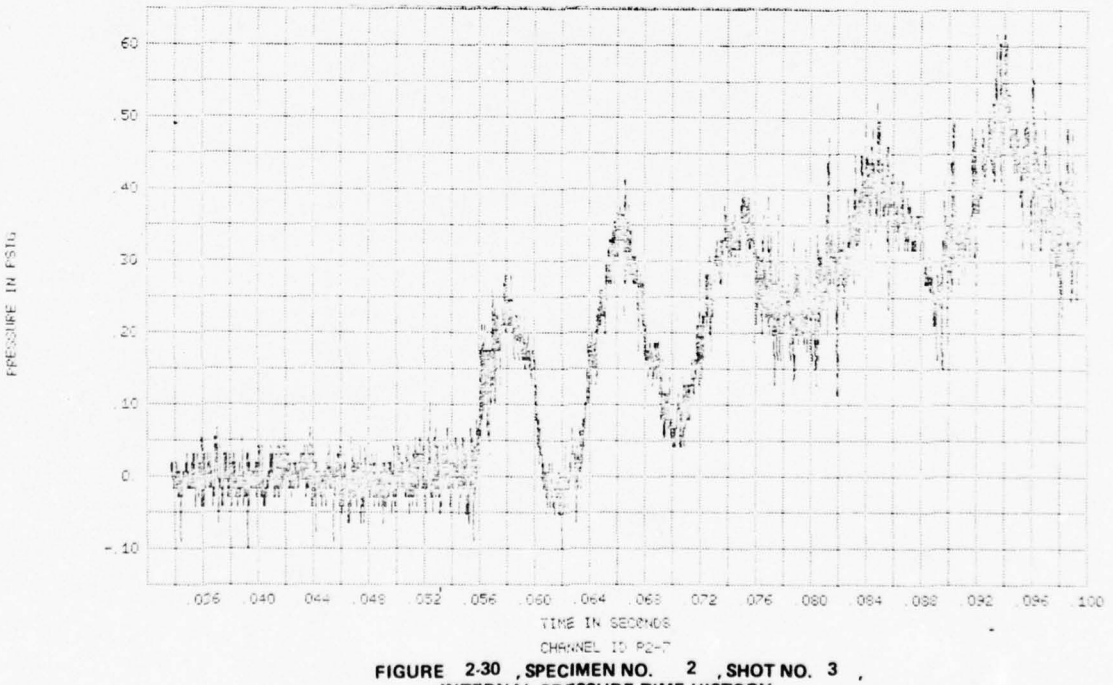


FIGURE 2-30 , SPECIMEN NO. 2 , SHOT NO. 3 ,
INTERNAL PRESSURE TIME HISTORY

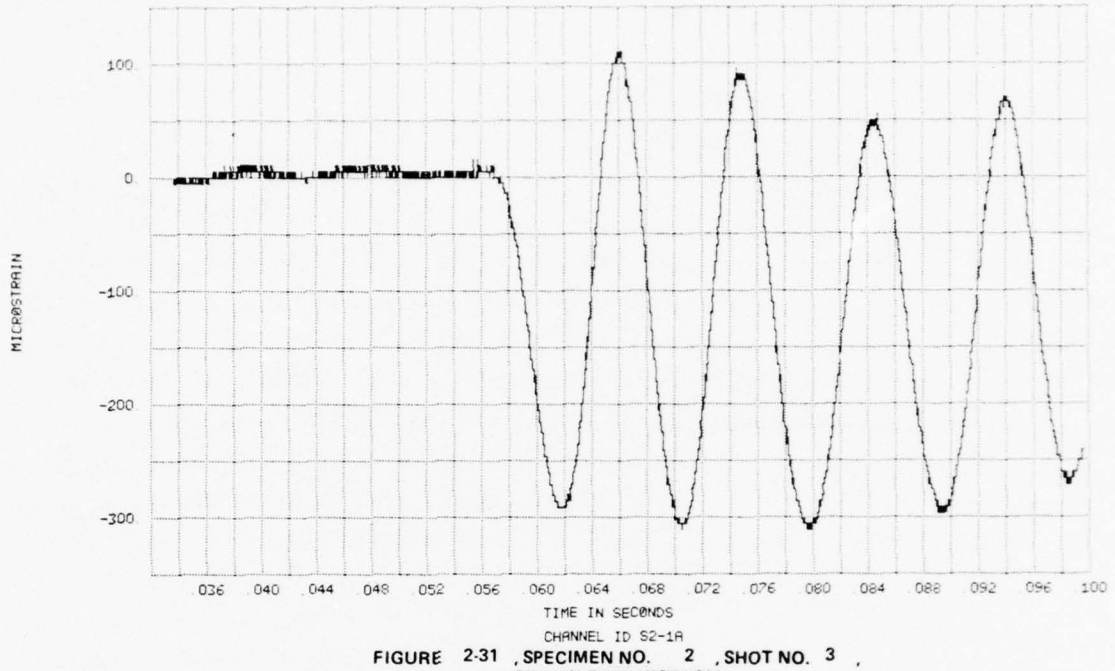


FIGURE 2-31 , SPECIMEN NO. 2 , SHOT NO. 3 ,
STRAIN TIME HISTORY

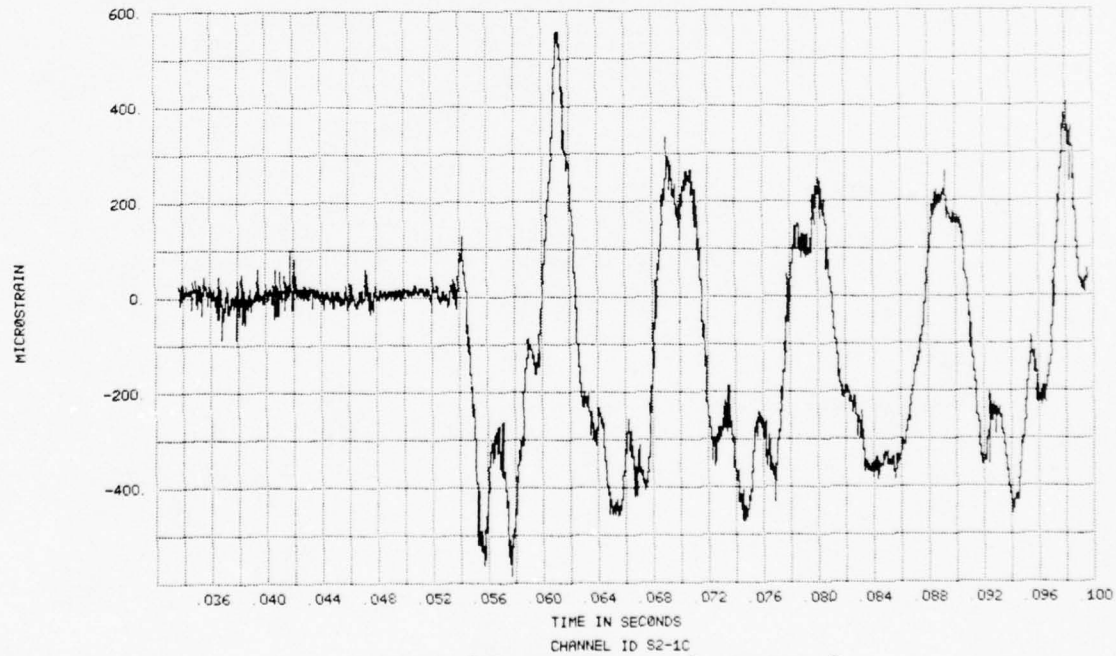


FIGURE 2-32 , SPECIMEN NO. 2 , SHOT NO. 3 ,
STRAIN TIME HISTORY

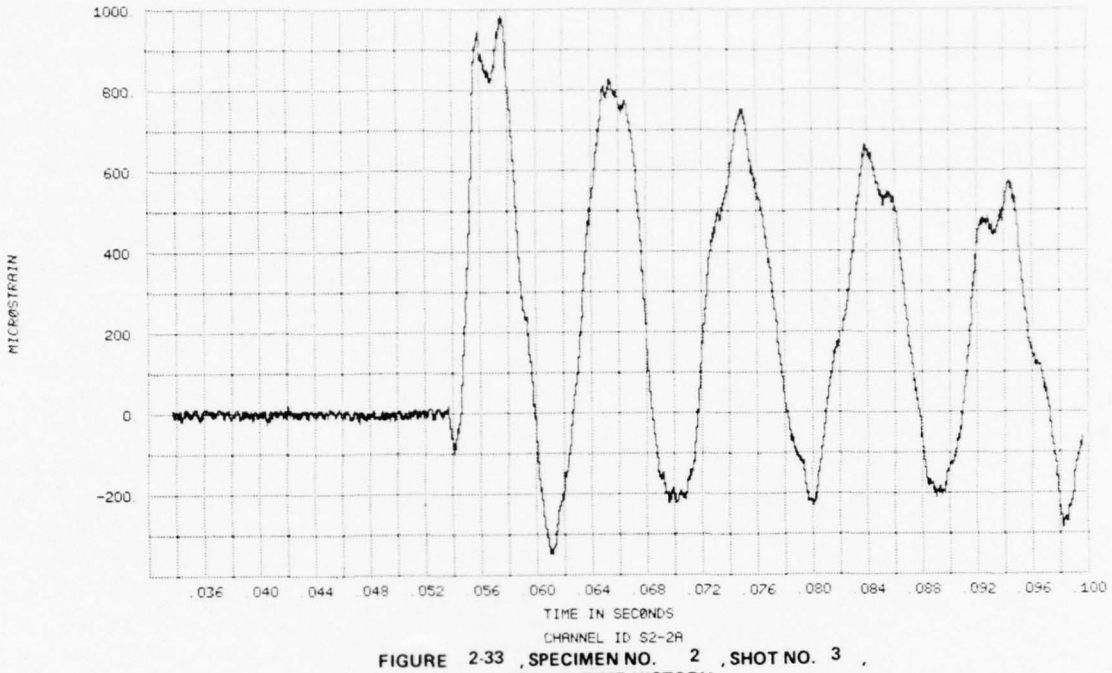


FIGURE 2-33 , SPECIMEN NO. 2 , SHOT NO. 3 ,
STRAIN TIME HISTORY

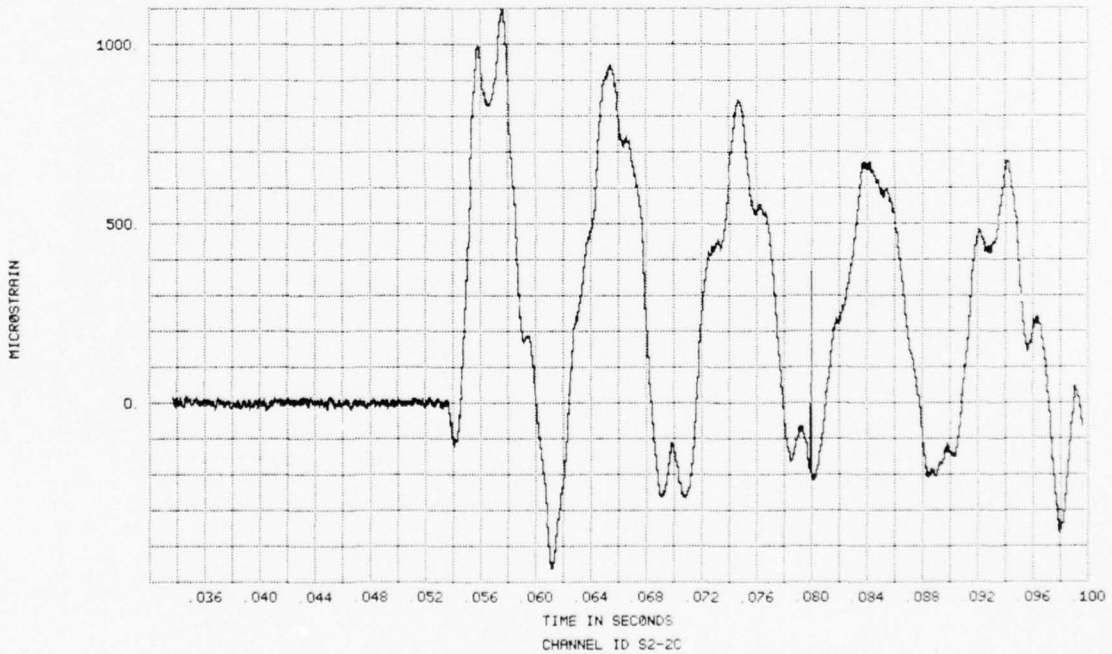


FIGURE 2-34 , SPECIMEN NO. 2 , SHOT NO. 3 ,
STRAIN TIME HISTORY

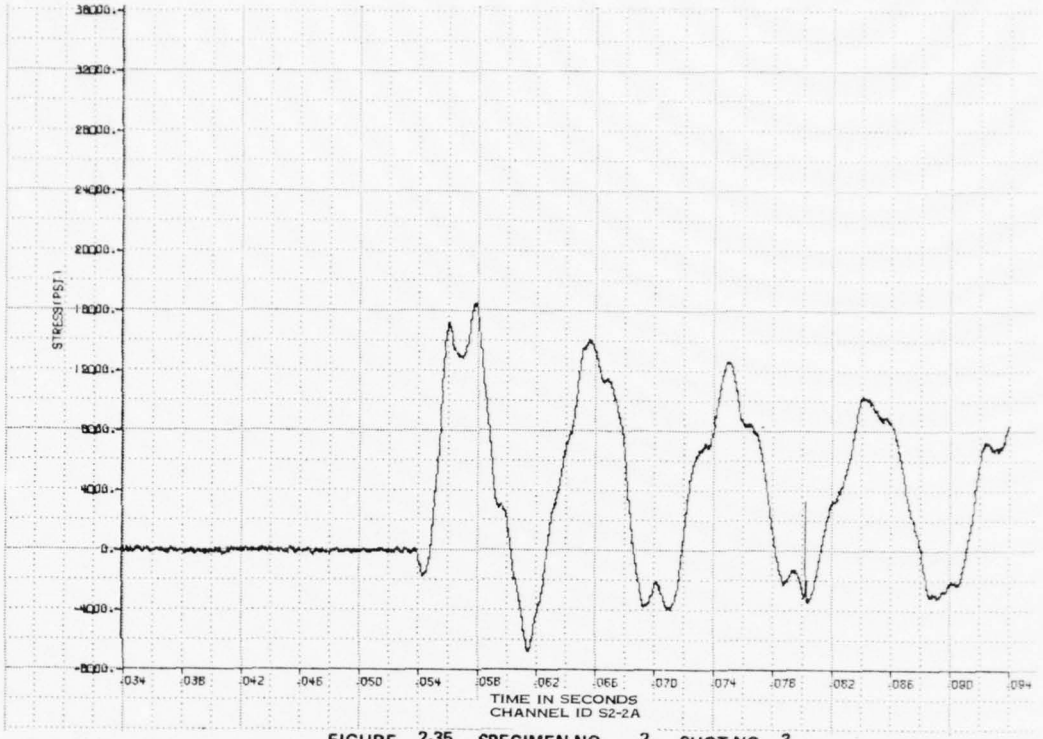


FIGURE 2-35 , SPECIMEN NO. 2 , SHOT NO. 3 ,
STRESS TIME HISTORY

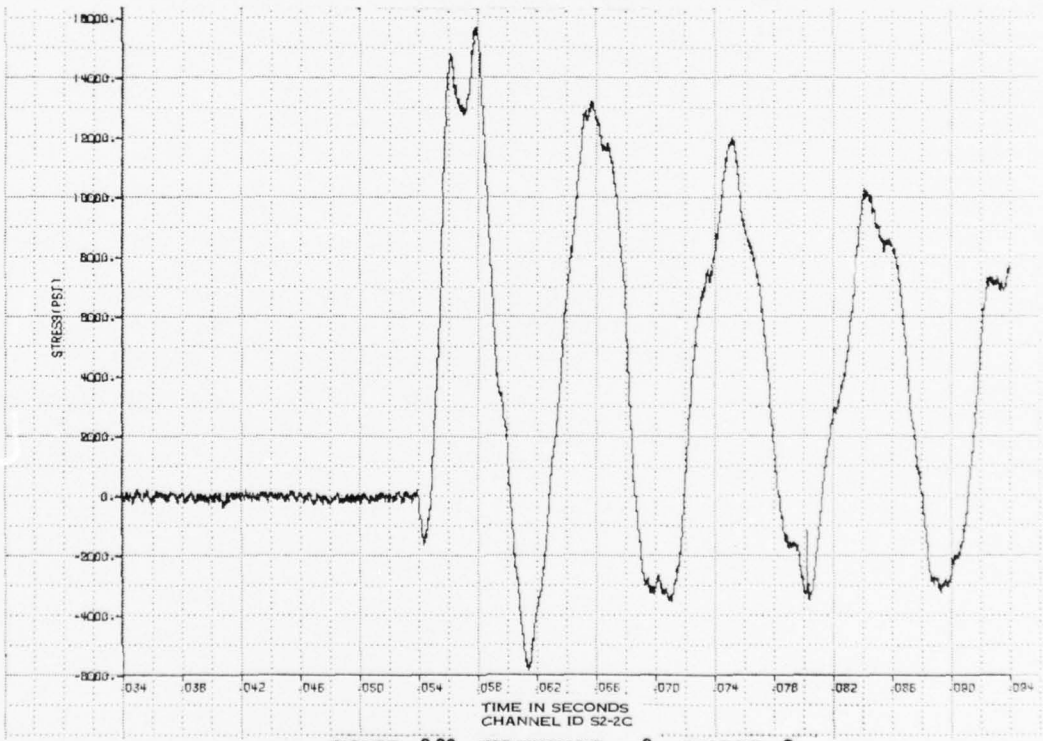


FIGURE 2-36 , SPECIMEN NO. 2 , SHOT NO. 3 ,
STRESS TIME HISTORY

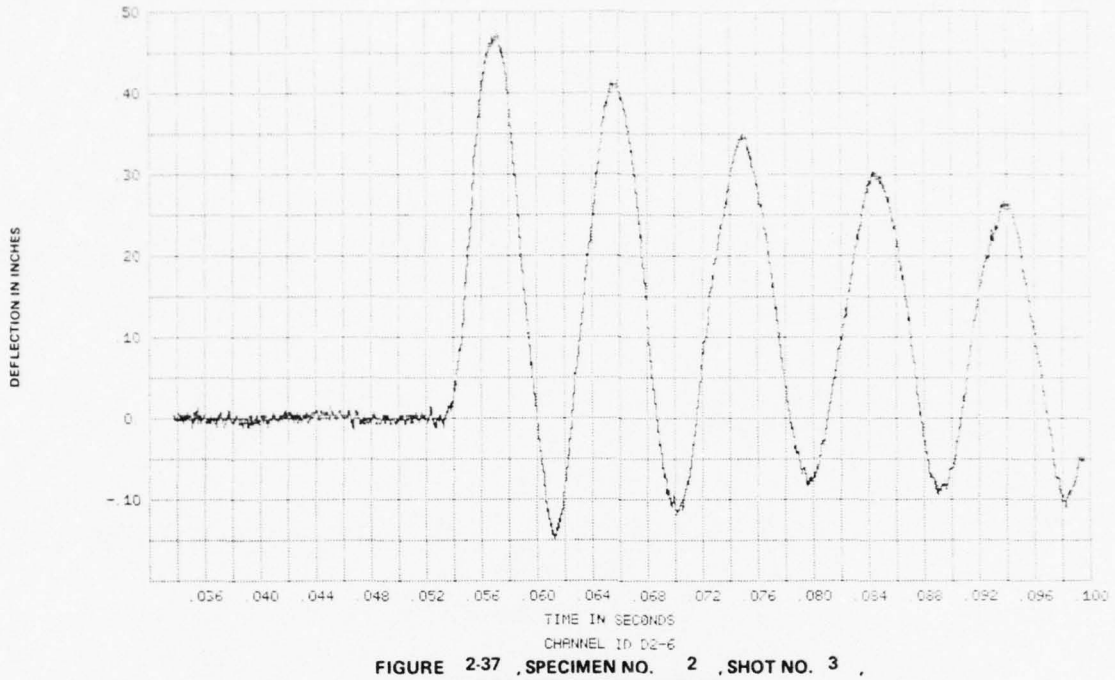


FIGURE 2-37 , SPECIMEN NO. 2 , SHOT NO. 3 ,
DEFLECTION TIME HISTORY

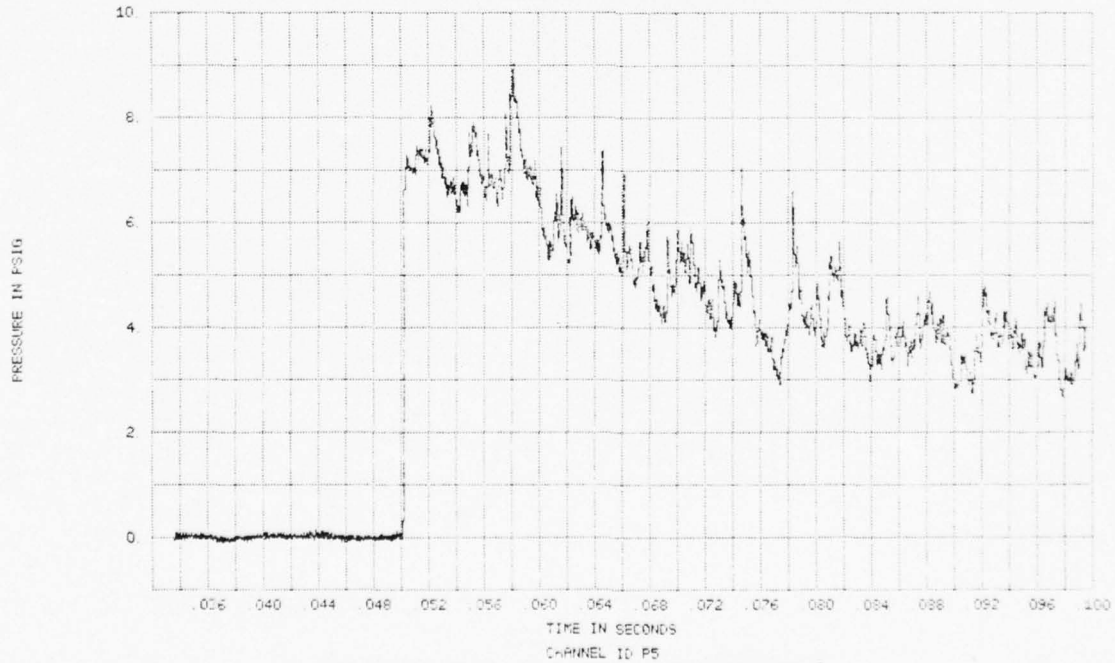


FIGURE 2-38 , SPECIMEN NO. 2 , SHOT NO. 4 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

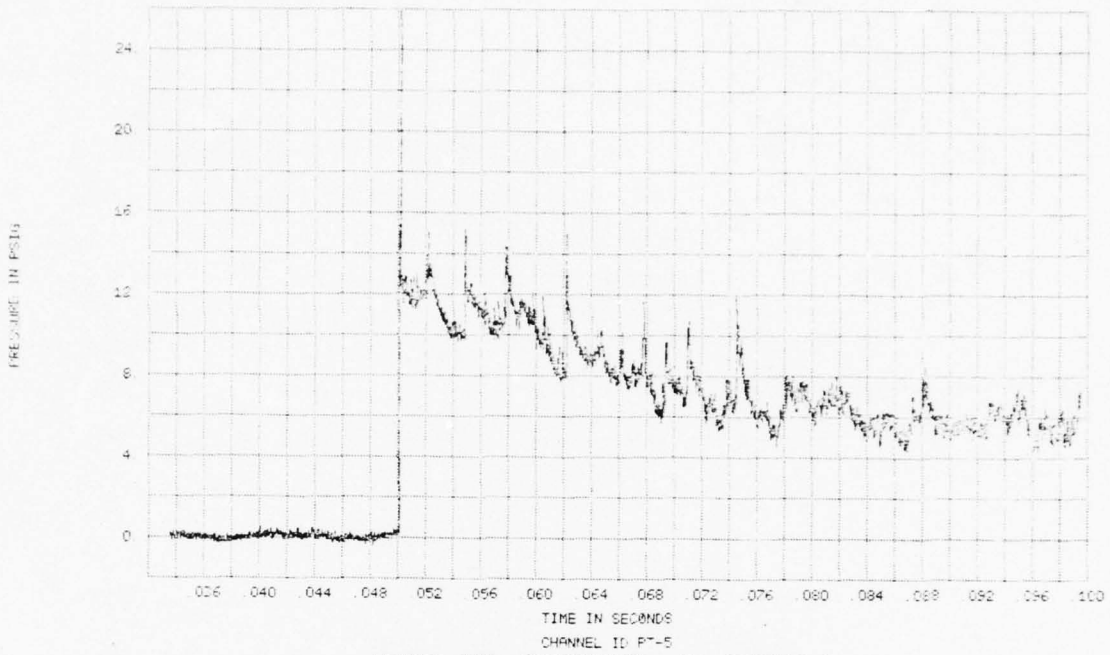


FIGURE 2-39 , SPECIMEN NO. 2 , SHOT NO. 4 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

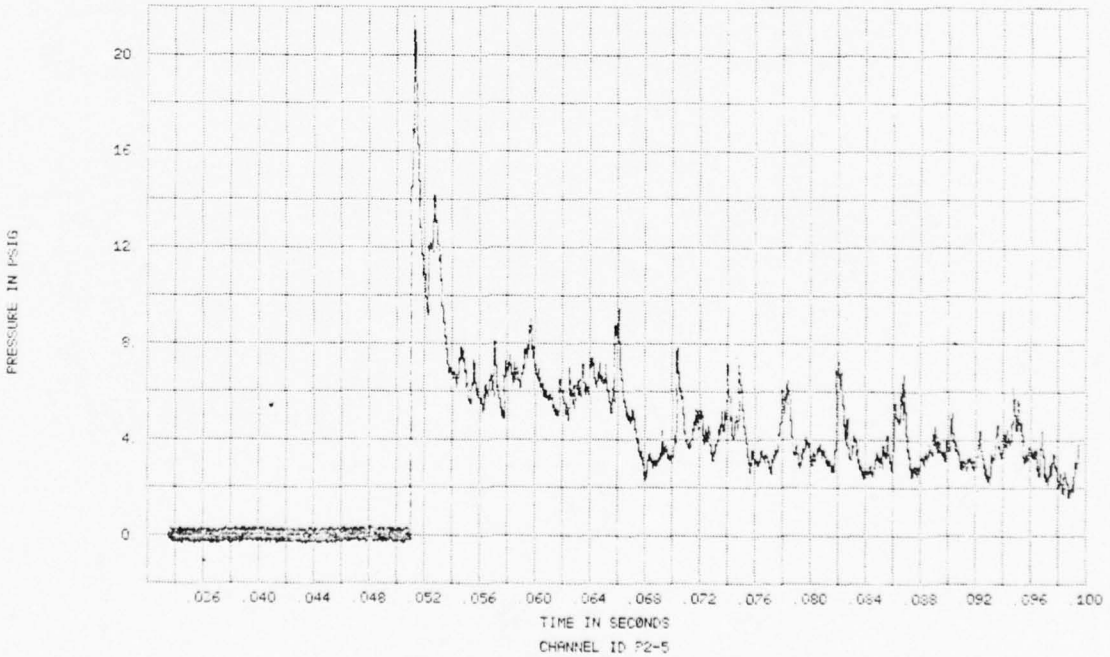


FIGURE 2-40 , SPECIMEN NO. 2 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

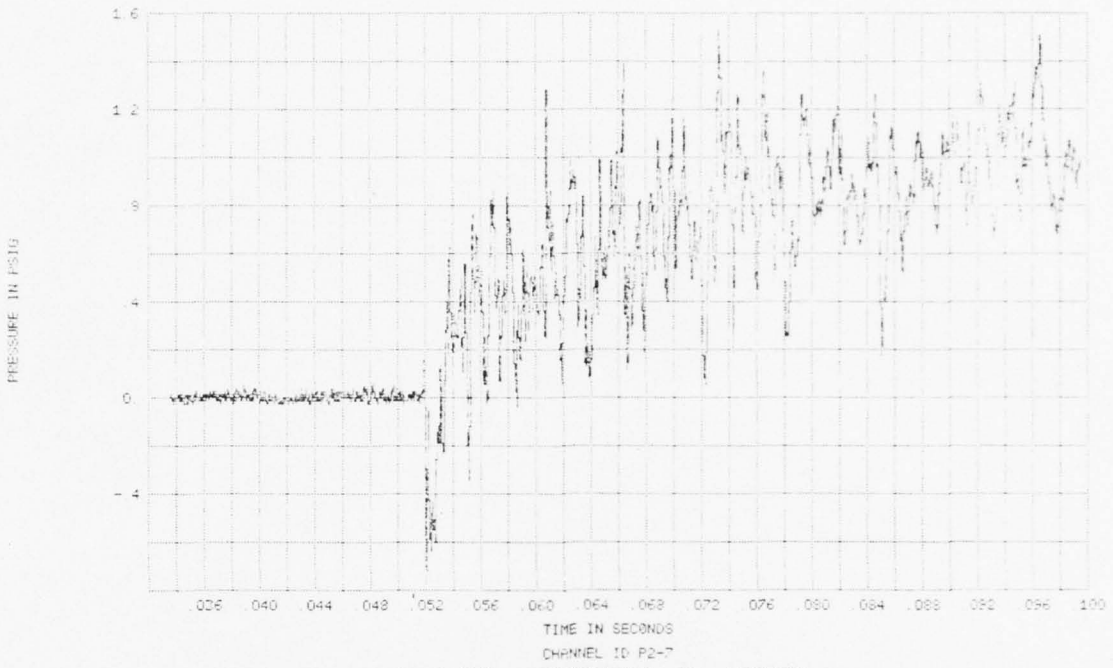


FIGURE 2-41 , SPECIMEN NO. 2 , SHOT NO. 4 ,
INTERNAL PRESSURE TIME HISTORY

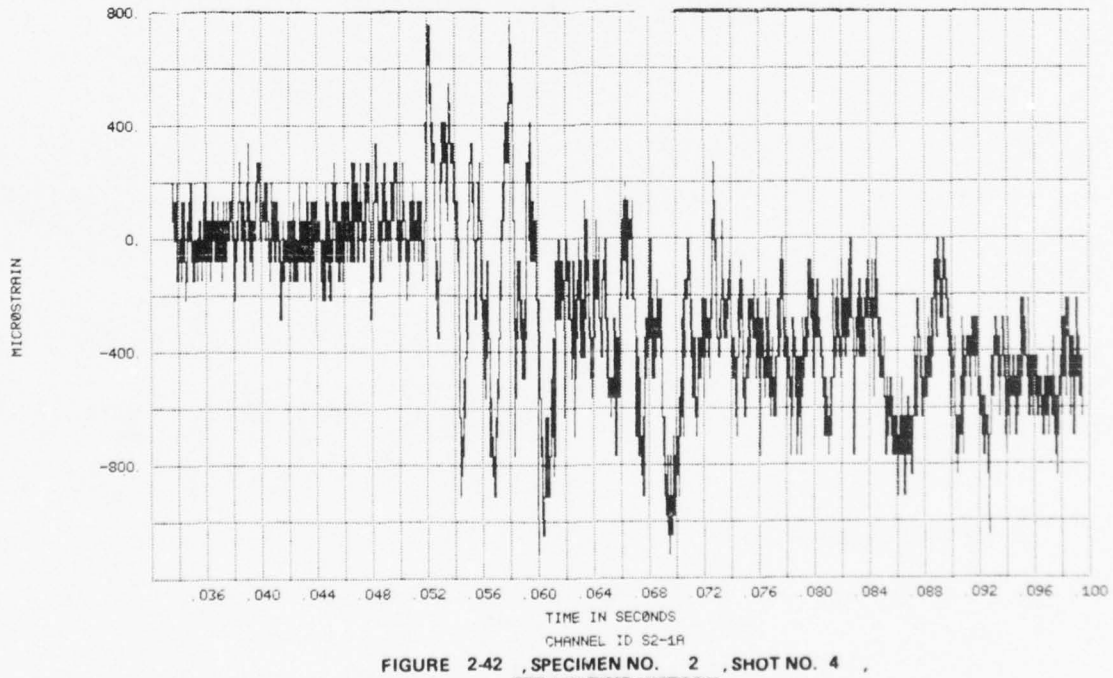


FIGURE 2-42 , SPECIMEN NO. 2 , SHOT NO. 4 ,
STRAIN TIME HISTORY

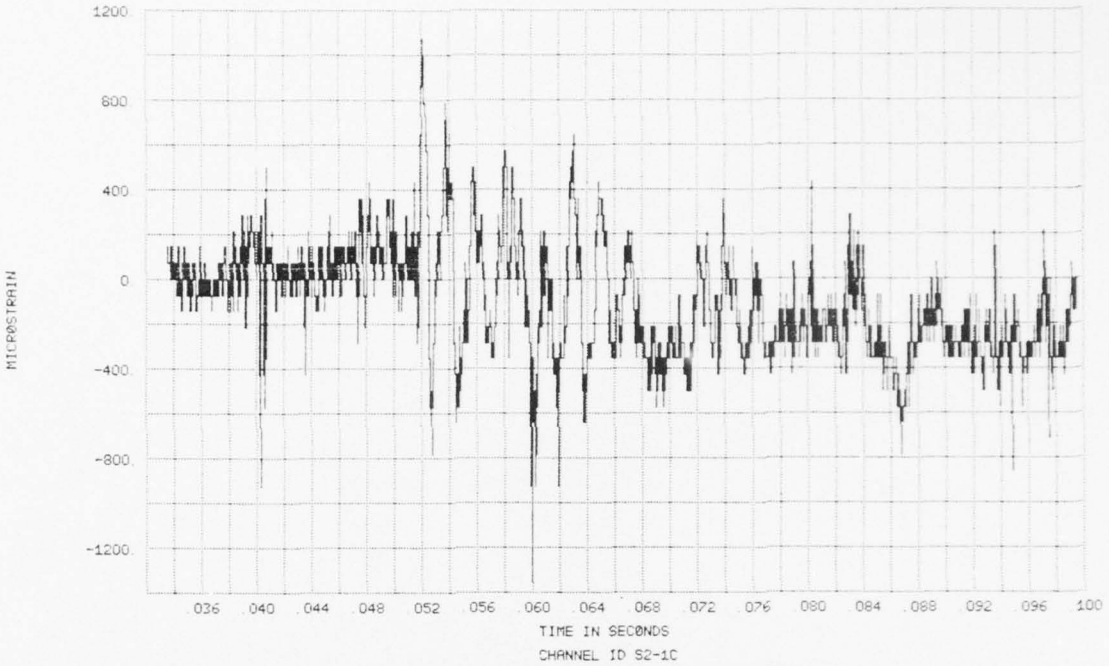


FIGURE 2-43 , SPECIMEN NO. 2 , SHOT NO. 4 ,
STRAIN TIME HISTORY

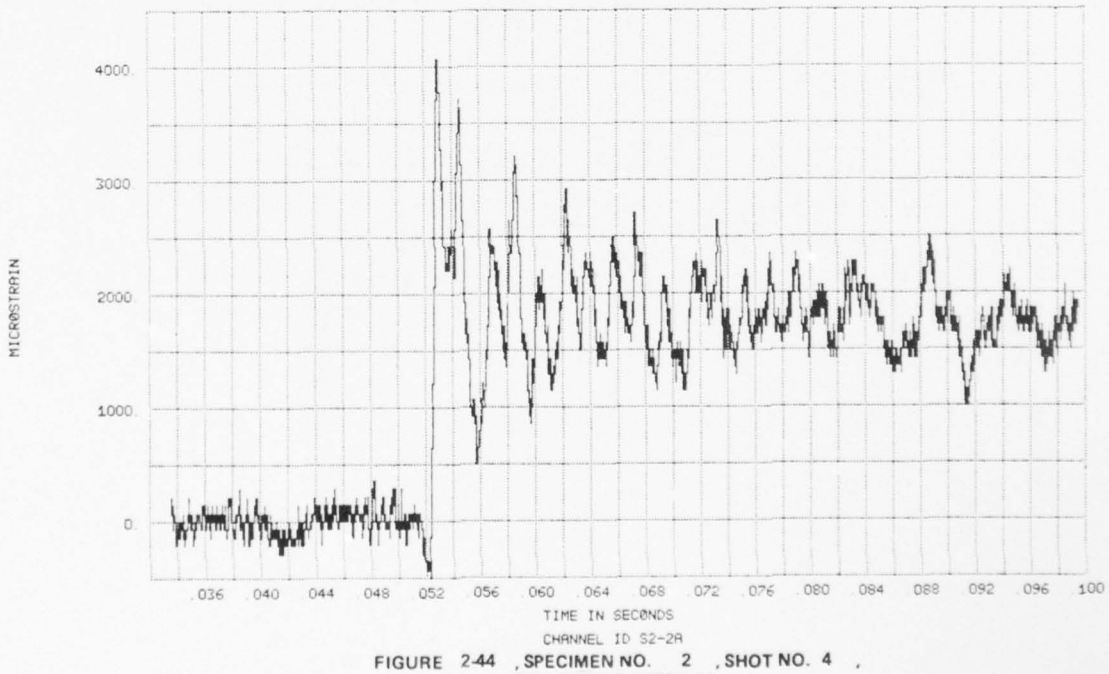


FIGURE 2-44 , SPECIMEN NO. 2 , SHOT NO. 4 ,
STRAIN TIME HISTORY

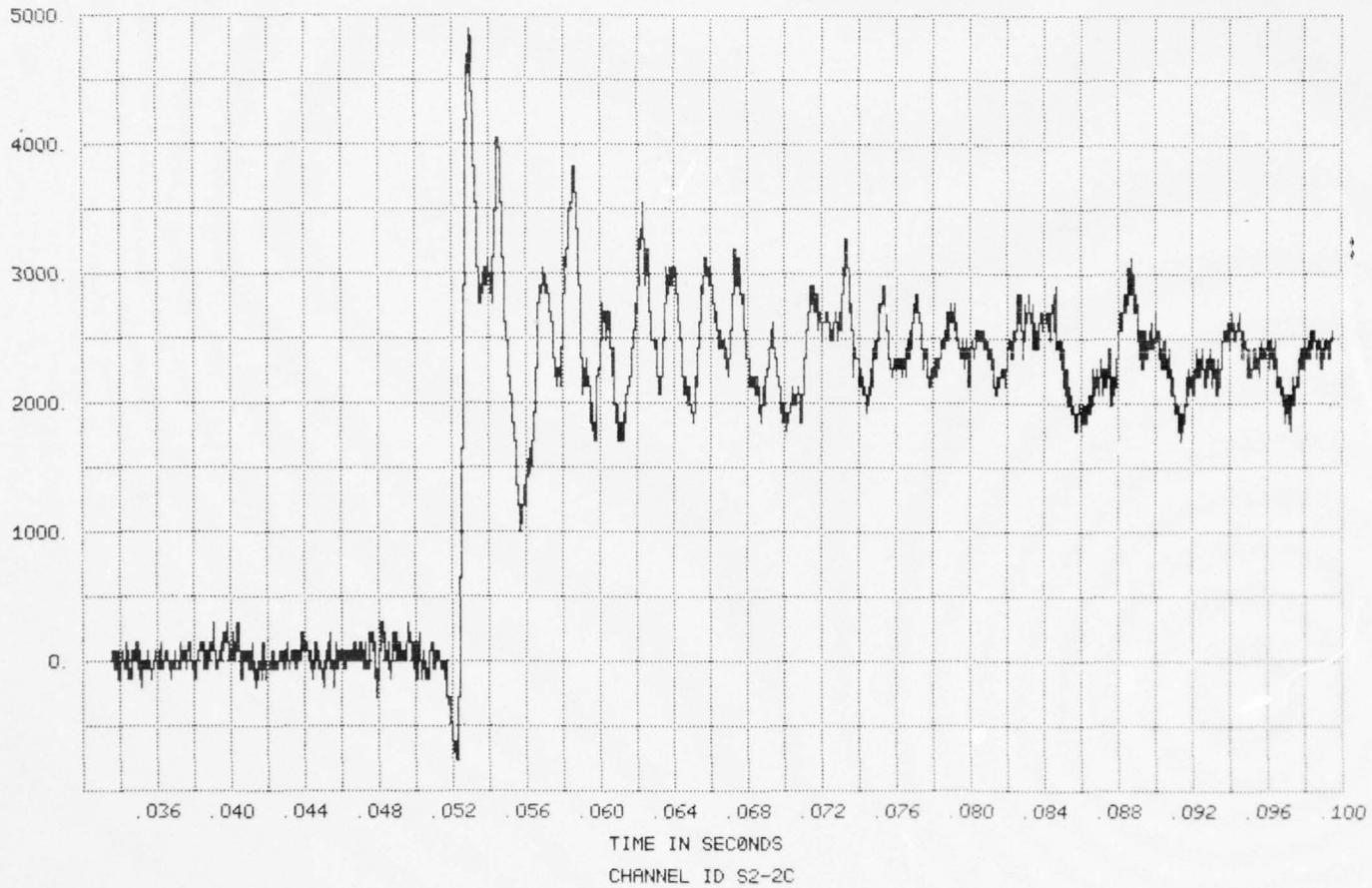
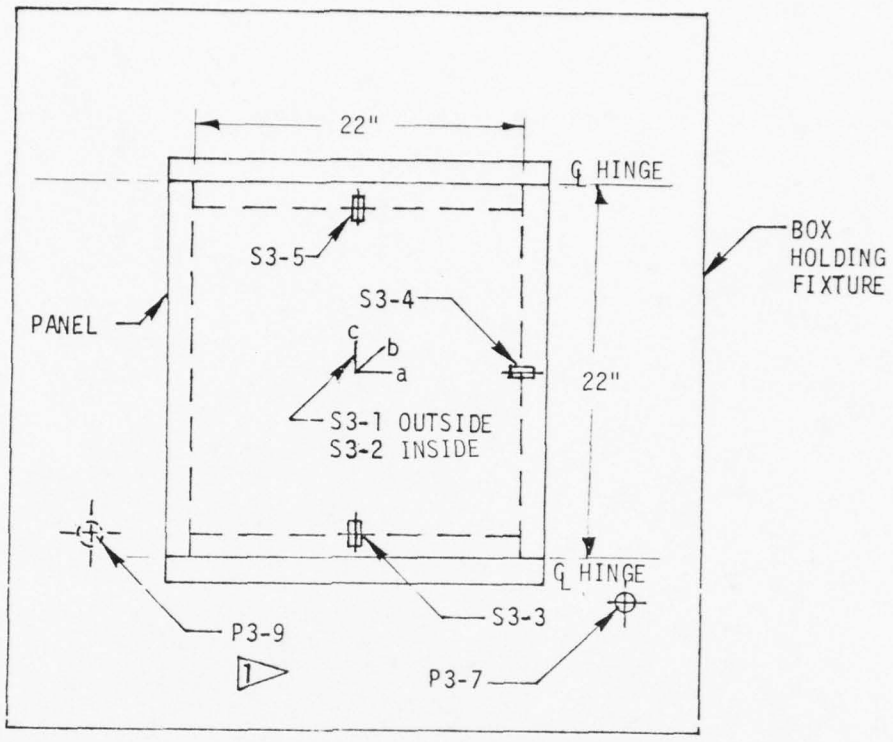


FIGURE 2-45 , SPECIMEN NO. 2 , SHOT NO. 4 ,
STRAIN TIME HISTORY



SPECIMEN NO. 3

FLAT UNSTIFFENED PANEL

TWO SIDES CLAMPED AND TWO SIDES PINNED

MATERIAL - 6061-T6 ALUMINUM ALLOY

DENSITY - .0002539 lb-sec^2/in^4 (MIL-HDBK-5)

POISSON'S RATIO - .33

MODULUS OF ELASTICITY - 10.9 x 10^6 PSI

SHEAR MODULUS - 3.8 x 10^6 PSI

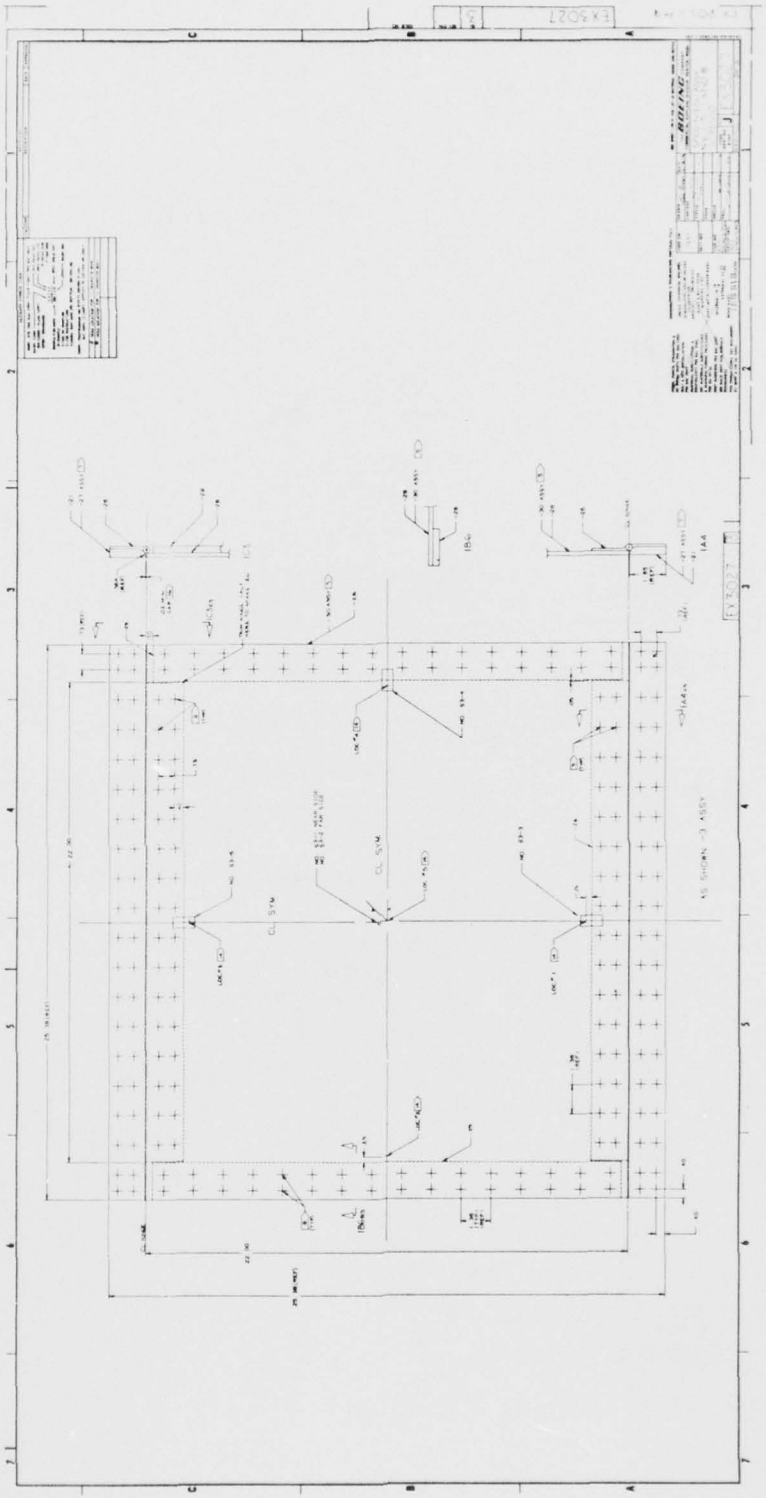
% ELONGATION - 15.0

F_{ty} - 40,500 PSI

F_{tu} - 45,200 PSI

THICKNESS - .193 IN.

1 ON BACK SIDE ON BOX HOLDING FIXTURE ONLY



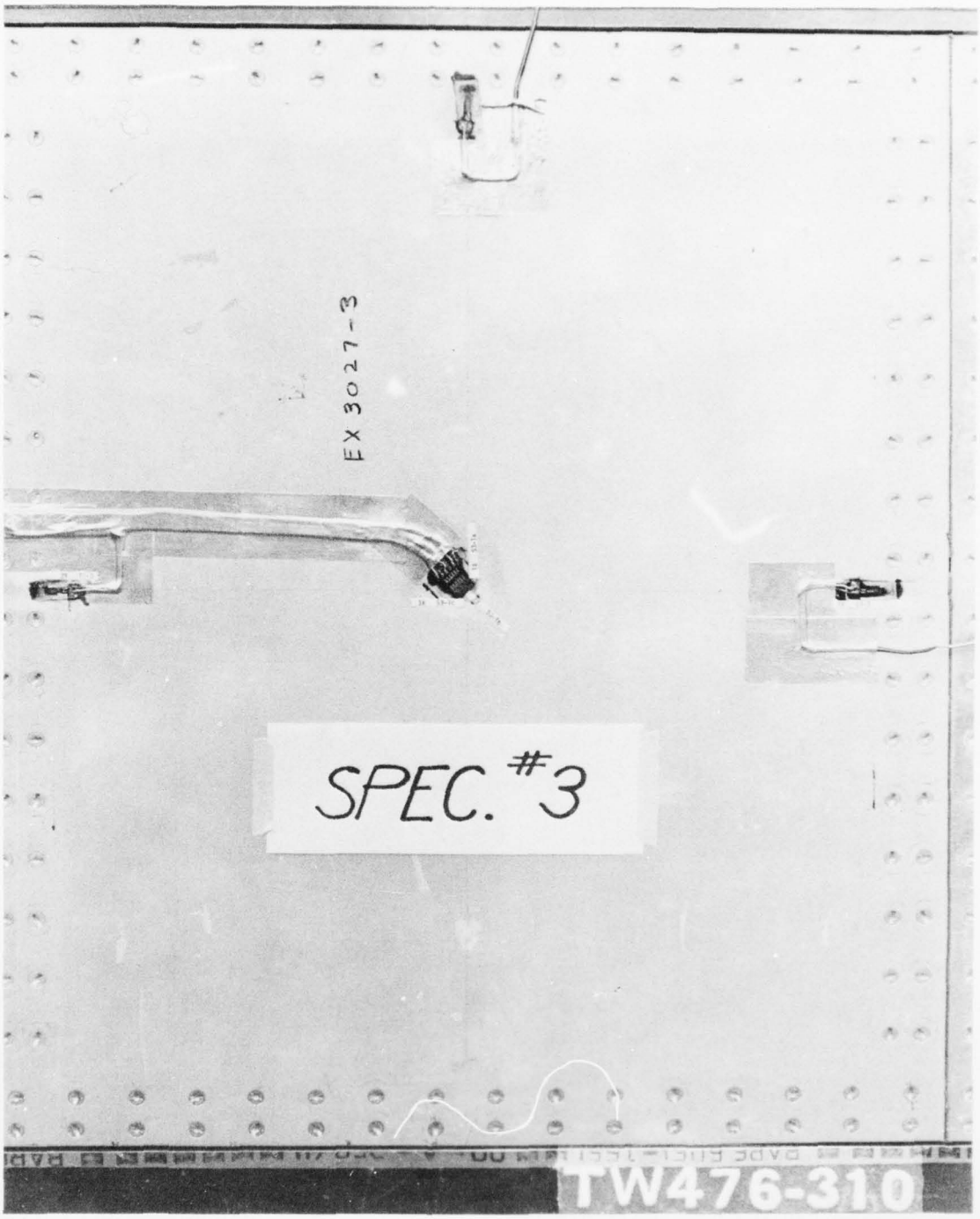


FIGURE 3-1 - SPECIMEN NO. 3 - INSTRUMENTATION - FRONT

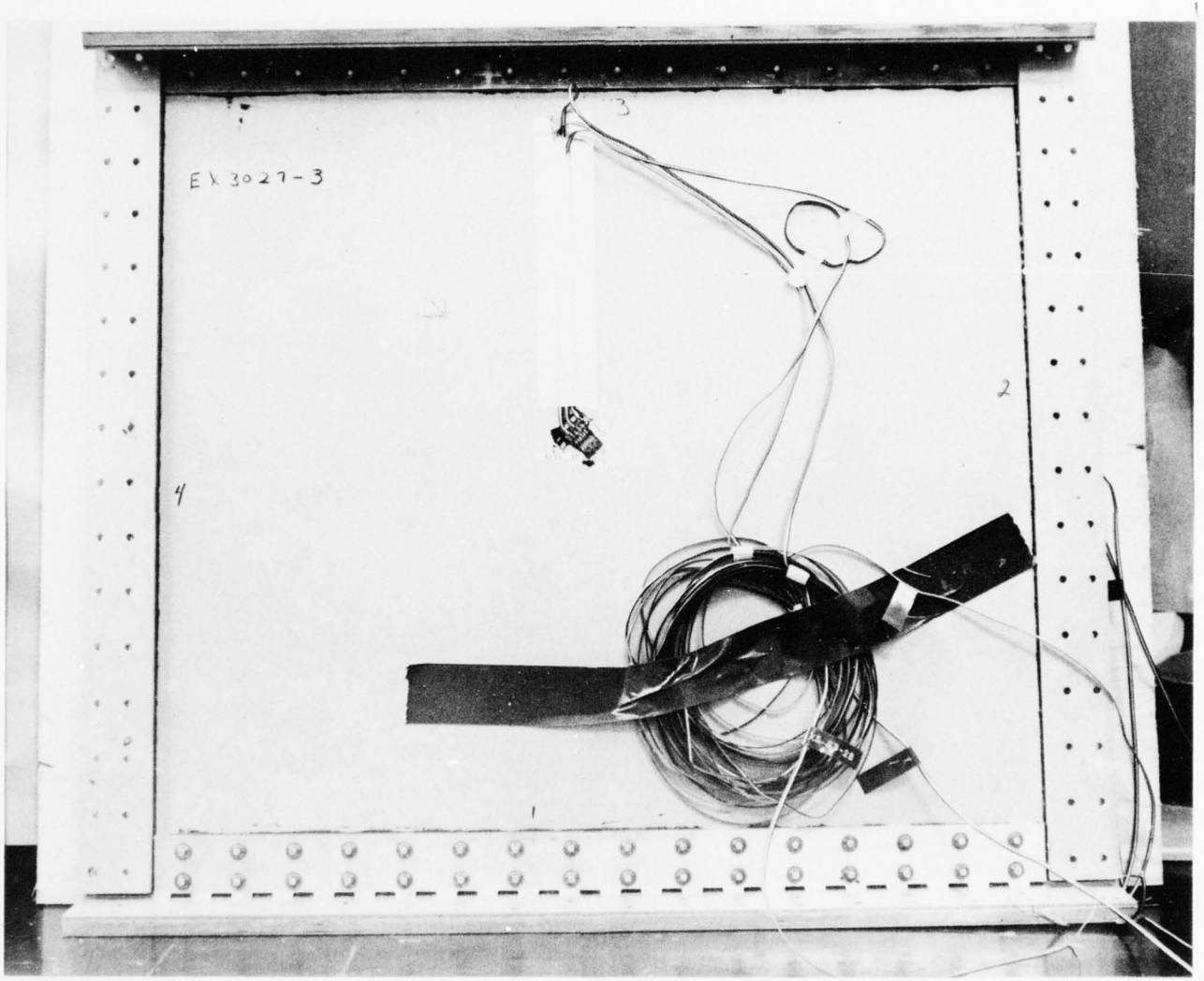


FIGURE 3-2 - SPECIMEN NO. 3 - INSTRUMENTATION - BACK

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.3 - STATIC ANALYSIS - PRESS = 5.0 PSI - MAY'76 - SYRING  GP   1
                1                0                                        GP   2
0.0              0.1              0.01            0.0                     GP   3
0.0              0.0              0.0             0.0                     GP   4
               15               15                                       GP   5
100000.                                                                  GP   7
                                                                         GP   8
                2                0                                       GP   9
                2                                                        GP  10
                0                0                                       GP  12
                0                0                                       GP  15
                2                2                                       GP  13
0.0              0.0                                                     GP  14
0.0              42.0                                                    GP  19
-42.0            0.0                                                     GP  20
-42.0            42.0                                                    GP  20
                0                                                        GP  21
                4                1               1                       GP  25
-21.0            0.0              21.0                                    GP  26
-5.0                                                                     GP  30
                5                5               11              11      GPP   1
                6                3               1                       GPP   2
               10                                                        GPP   3
                2                5                                       GPP   4
                3                4                                       GPP   4
                3                5                                       GPP   4
                4                3                                       GPP   4
                4                4                                       GPP   4
                4                5                                       GPP   4
                5                2                                       GPP   4
                5                3                                       GPP   4
                5                4                                       GPP   4
                5                5                                       GPP   4
                1                                                        GPP   5
22.0             22.0                                                    GPP   6
0.19             .0002539                                                GPP   7
10900000.        10900000.        0.33            0.33          3800000. GPP   8
40500.           40500.                                                  GPP   9
0.0              0.0              0.0             0.0           0.0   0.0 GPP  13
0.0              0.0              0.0             0.0           0.0   0.0 GPP  13
0.0              0.0              0.0             0.0           0.0   0.0 GPP  13
0.0              0.0              0.0             0.0           0.0   0.0 GPP  13
0.0                                                                      GPP  13
.000001          .000001          1.0                                     GPP  14
                                                                         GP  32
```

TABLE XXV

STATIC TEST STRESSES - SPECIMEN NO. 3
(STRESSES GIVEN IN PSI)

STRAIN GAUGE	STATIC PRESSURE (PSI)				
	1.0	2.0	3.0	4.0	5.0
S3-1	-2349.	-3993.	-5111.	-5831.	-6319.
S3-2	2711.	5139.	7311.	9246.	10915.
S3-3	-318.	-306.	-122.	-73.	-16.
S3-4	4589.	8795.	12746.	16629.	19608.
S3-5	-367.	-514.	-551.	-722.	-979.

TABLE XXVI

STATIC TEST DISPLACEMENTS - SPECIMEN NO. 3
(DISPLACEMENT MEASURED AT CENTER OF PANEL)

	STATIC PRESSURE (PSI)				
	1.0	2.0	3.0	4.0	5.0
DISPLACEMENT (INCHES)	.068	.123	.169	.207	.241

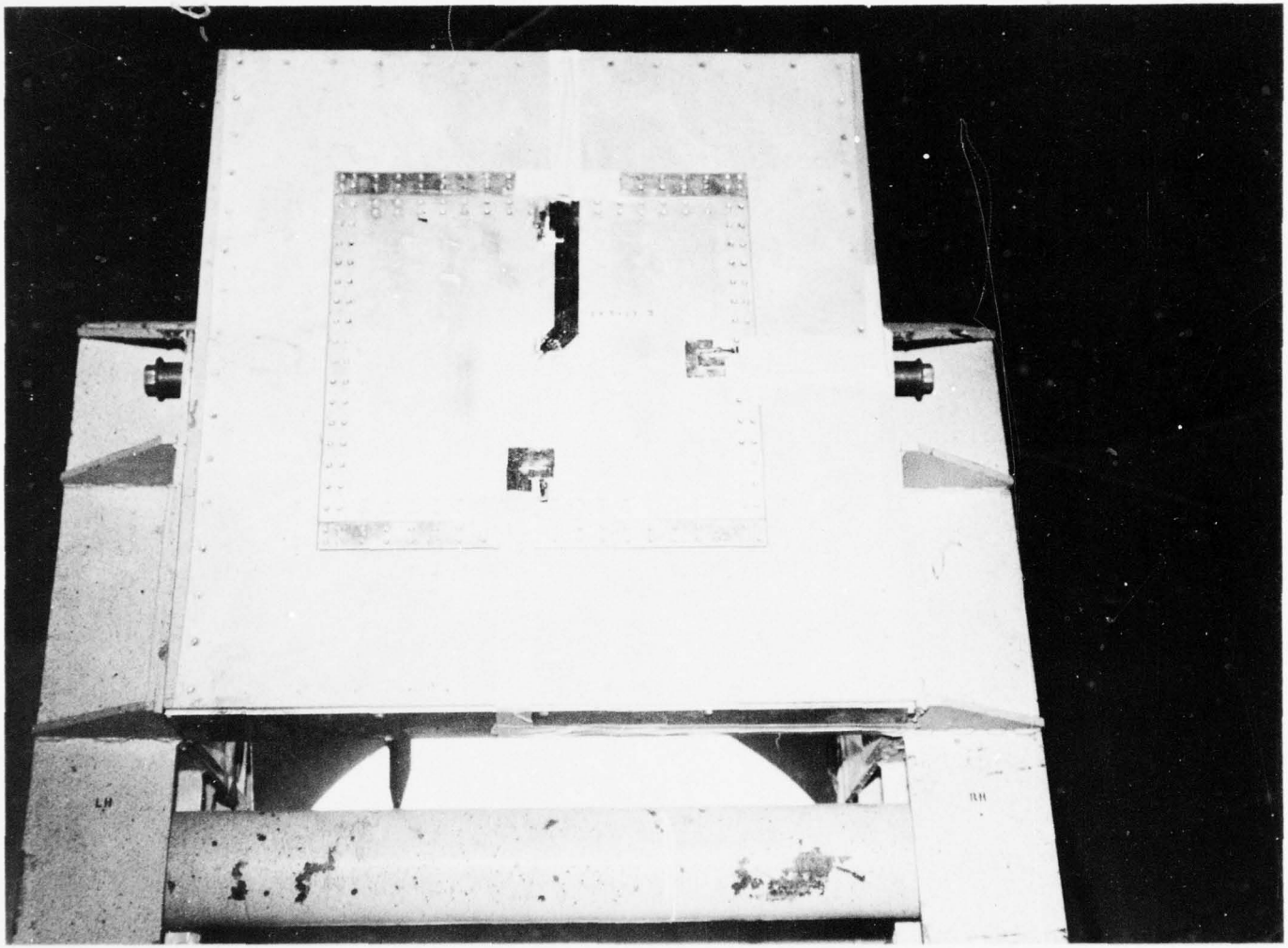


FIGURE 3-3 - SPECIMEN NO. 3 - SHOCK TEST SET-UP

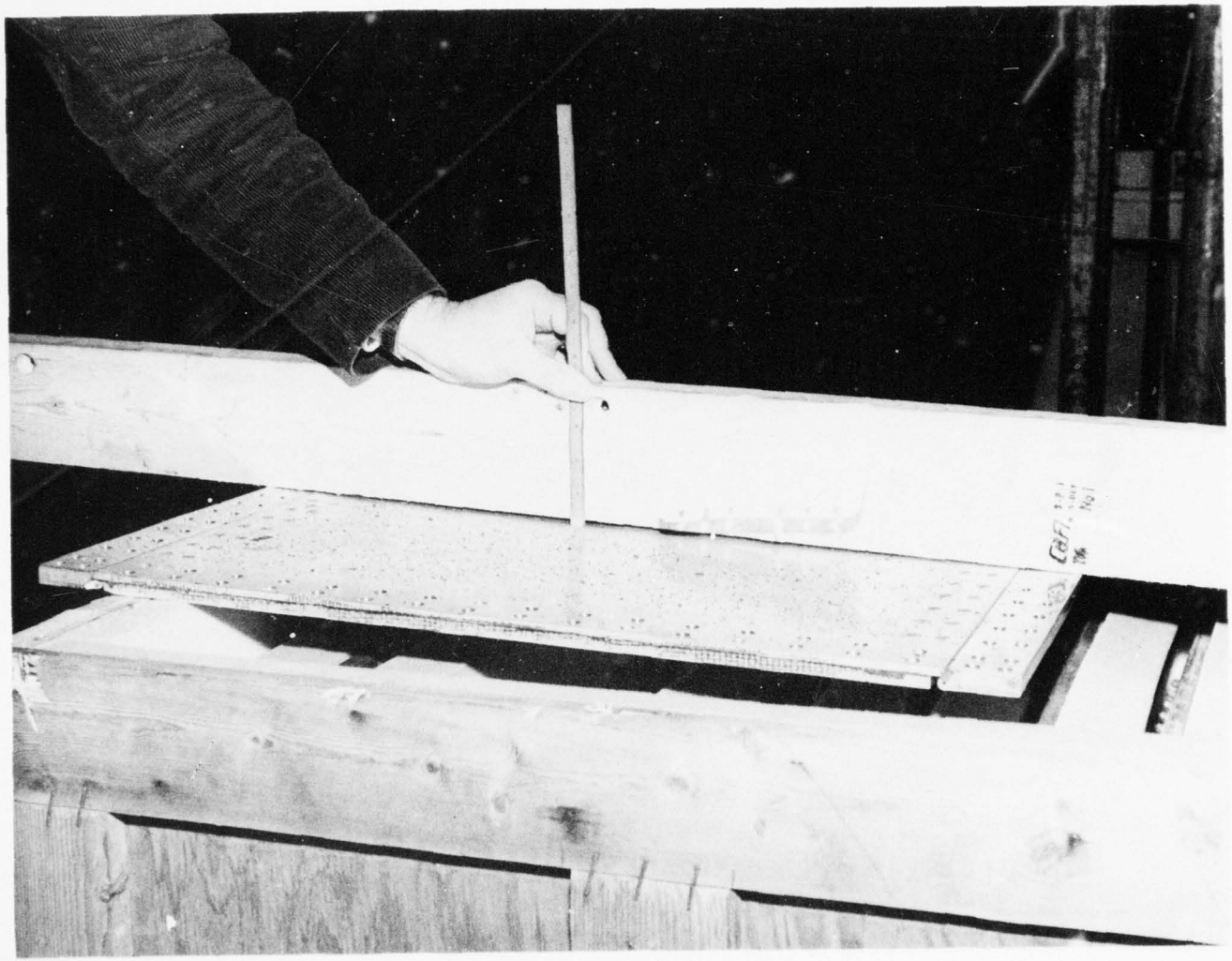


FIGURE 3-4 - SPECIMEN NO. 3 - INDICATION OF SHOCK TEST PERMANENT DEFORMATION

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.3 -DYNAMIC ANALYSIS - ITERATIVE TPO SOLUTION                    GP  1
          1              0                                                       GP  2
5000.      0.001          0.02          0.0                                     GP  3
0.0        0.0            0.0           0.0                                     GP  4
         15             15                                                      GP  5
400.                                                                            GP  7
                                                                                GP  8
          2              0                                                       GP  9
          0              1                                                       GP 10
0.5                                                                             GP 11
          0              0                                                       GP 12
          0              0                                                       GP 15
          2              2                                                       GP 18
48.0       0.0                                                                  GP 19
20.0       96.0                                                                 GP 19
-60.0      0.0                                                                  GP 20
-70.0      96.0                                                                 GP 20
          0                                                                     GP 21
          4              1             1                                       GP 25
-21.0      0.0           21.0                                                   GP 26
                                                                                GP 30
          5              5             11            11            6           GPP  1
          0              3             1                                       GPP  2
         10                                                                     GPP  3
          2              5                                                       GPP  4
          3              4                                                       GPP  4
          3              5                                                       GPP  4
          4              3                                                       GPP  4
          4              4                                                       GPP  4
          4              5                                                       GPP  4
          5              2                                                       GPP  4
          5              3                                                       GPP  4
          5              4                                                       GPP  4
          5              5                                                       GPP  4
          1                                                                     GPP  5
22.0       22.0                                                                 GPP  6
0.193      .0002539                                                             GPP  7
10900000.  10900000.      0.33          0.33          3800000.                  GPP  8
40500.     40500.                                                               GPP  9
0.0        0.0            0.0           0.0           0.0           0.0         GPP 13
0.0        0.0            0.0           0.0           0.0           0.0         GPP 13
0.0        0.0            0.0           0.0           0.0           0.0         GPP 13
0.0        0.0            0.0           0.0           0.0           0.0         GPP 13
0.0                                                                             GPP 13
0.0        0.010         25.0                                                   GPP 14
                                                                                GP  32
```

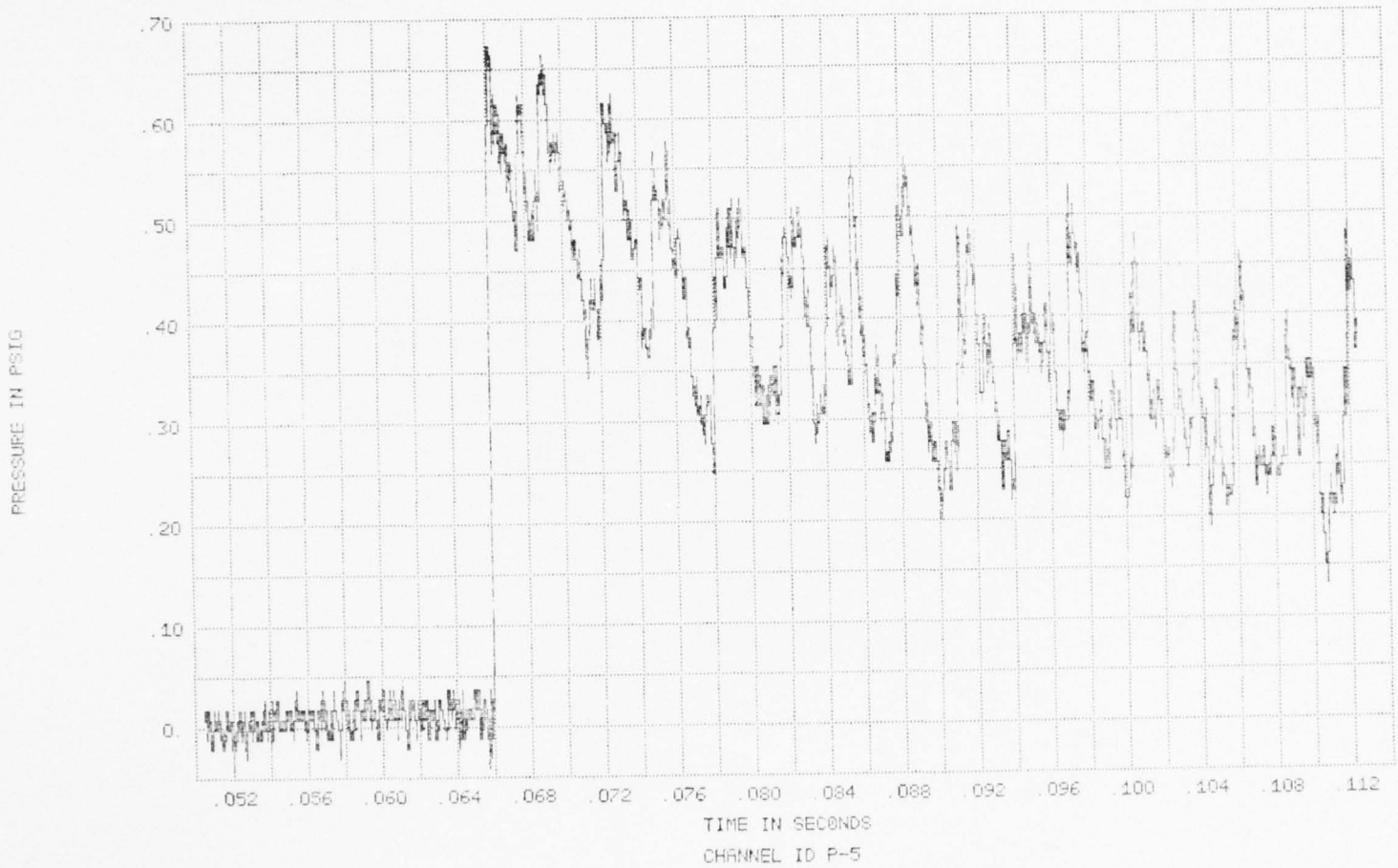


FIGURE 3-5 , SPECIMEN NO. 3 , SHOT NO. 1 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

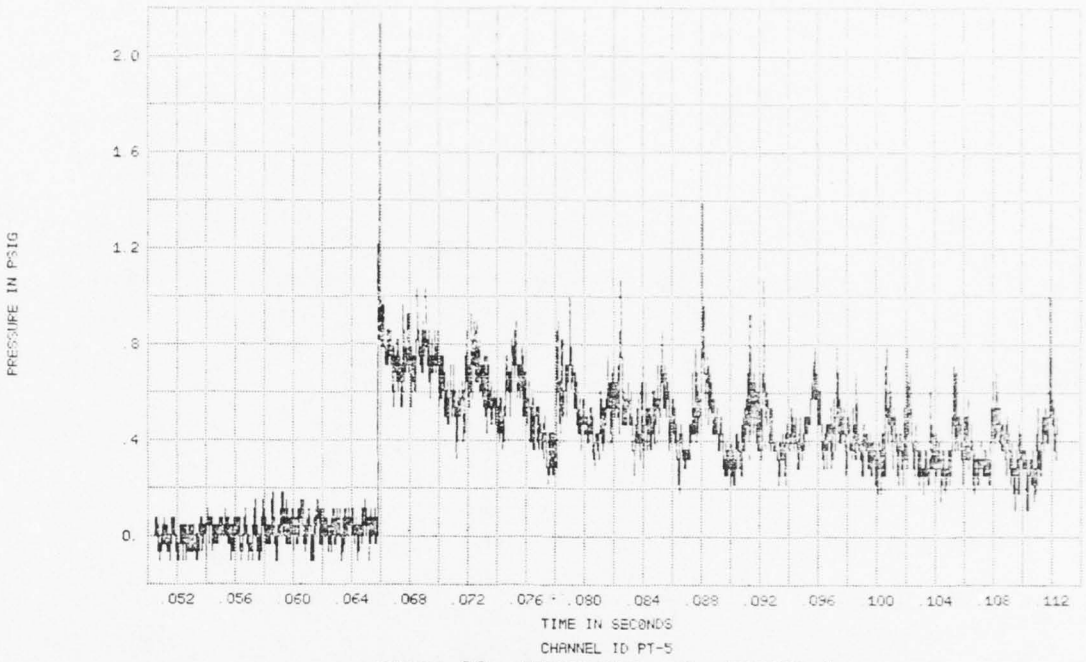


FIGURE 3-6 , SPECIMEN NO. 3 , SHOT NO. 1 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

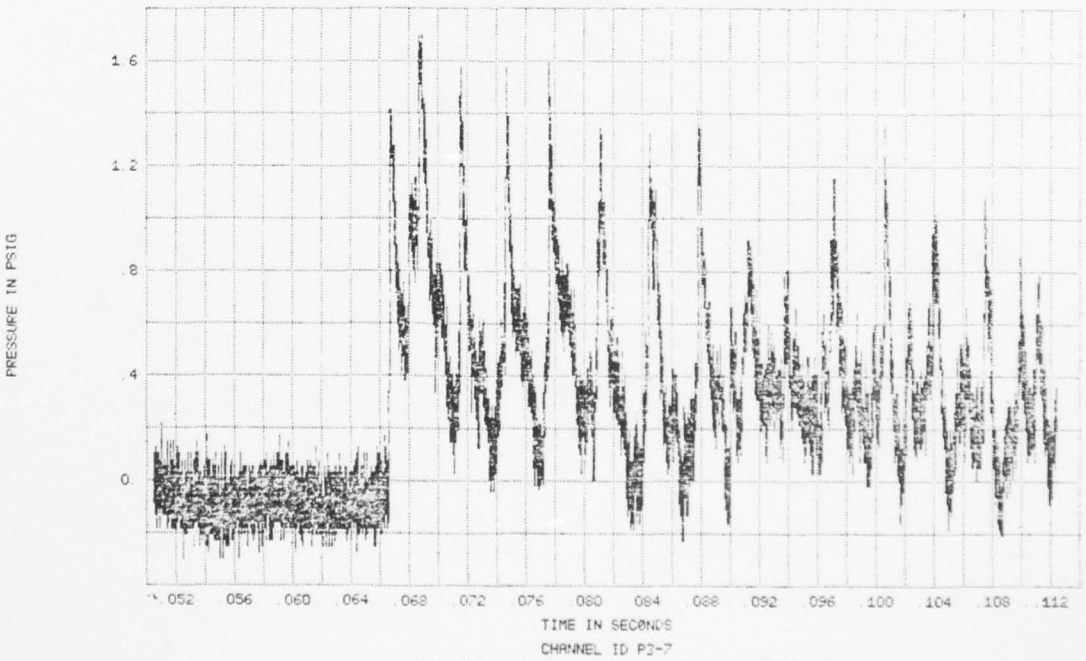


FIGURE 3-7 , SPECIMEN NO. 3 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

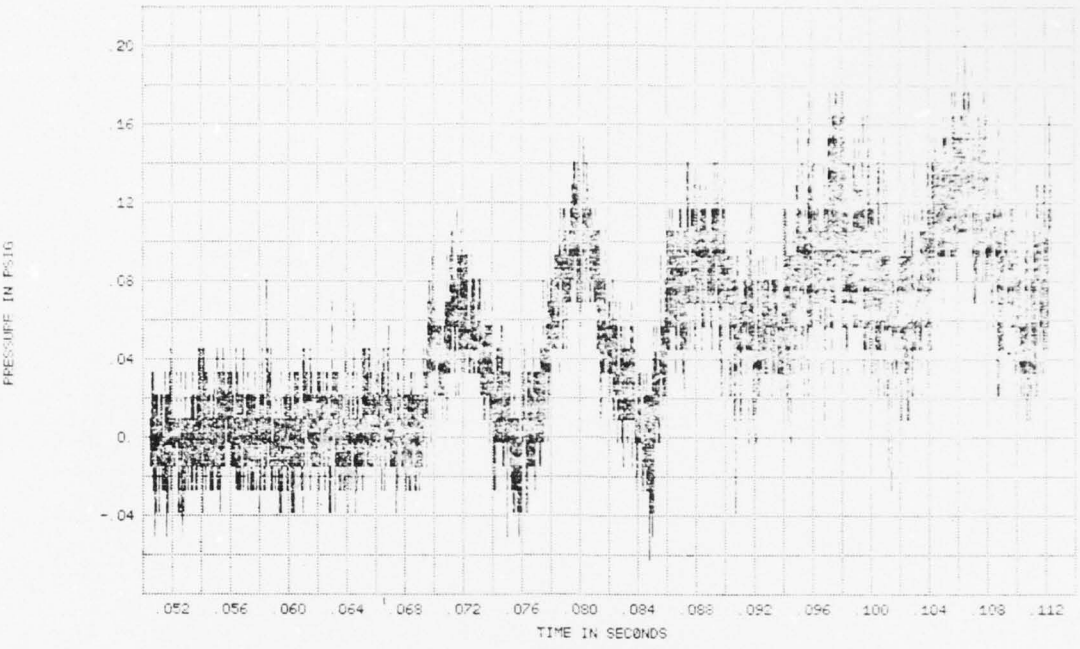


FIGURE 3-8 , SPECIMEN NO. 3 , SHOT NO. 1 ,
INTERNAL PRESSURE TIME HISTORY

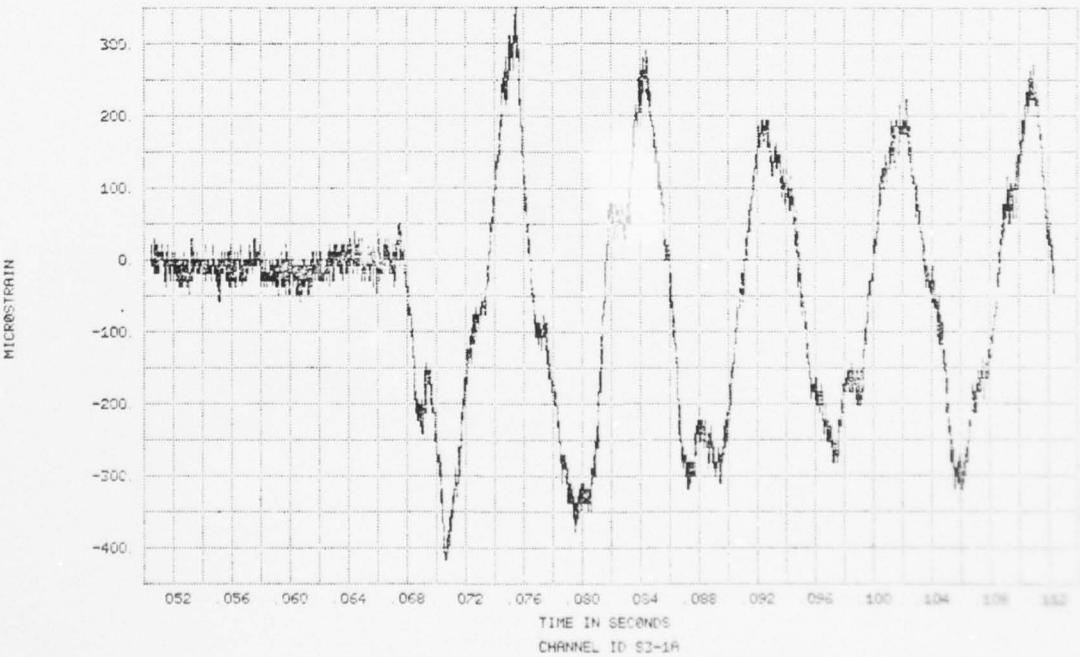
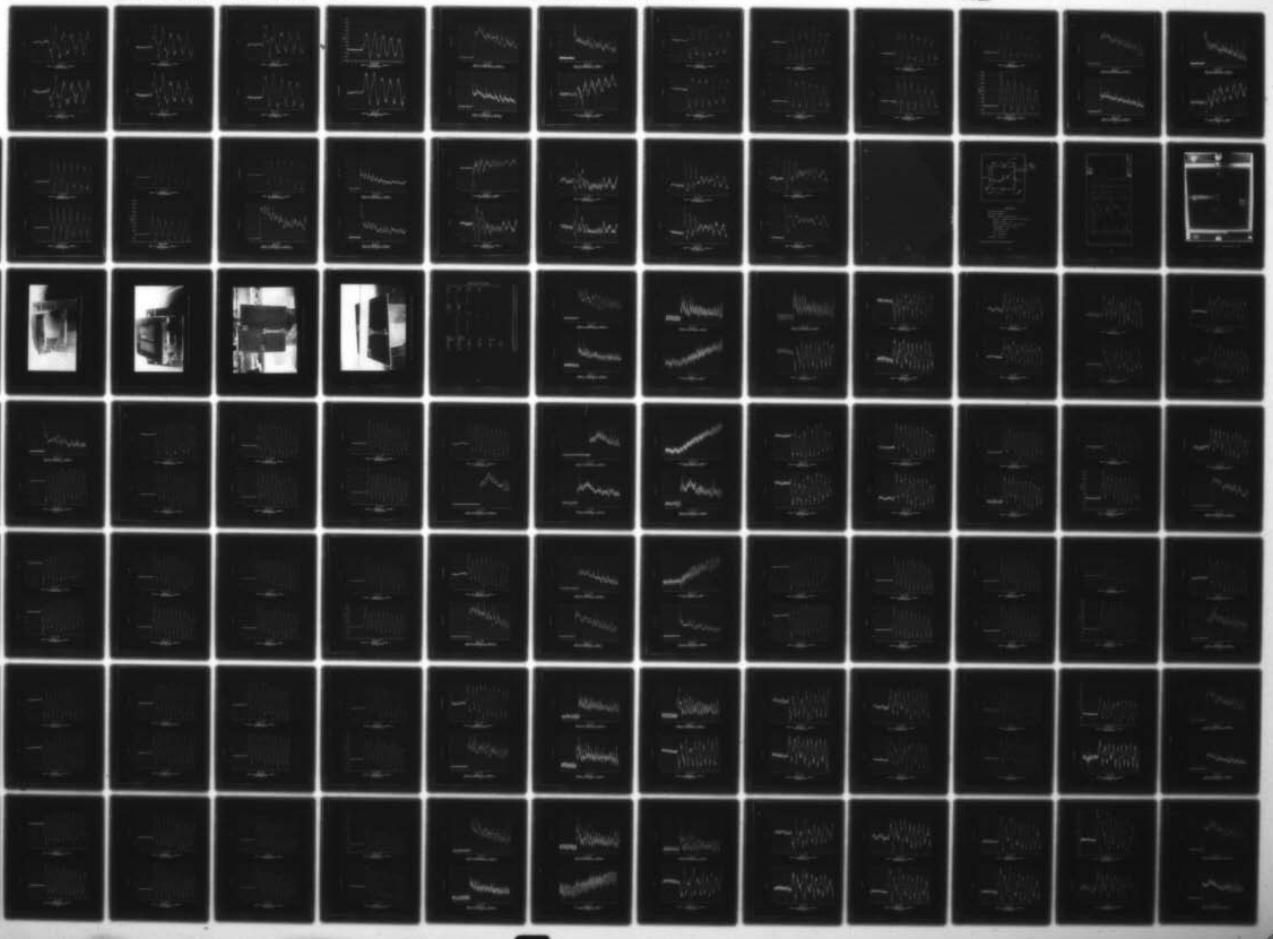
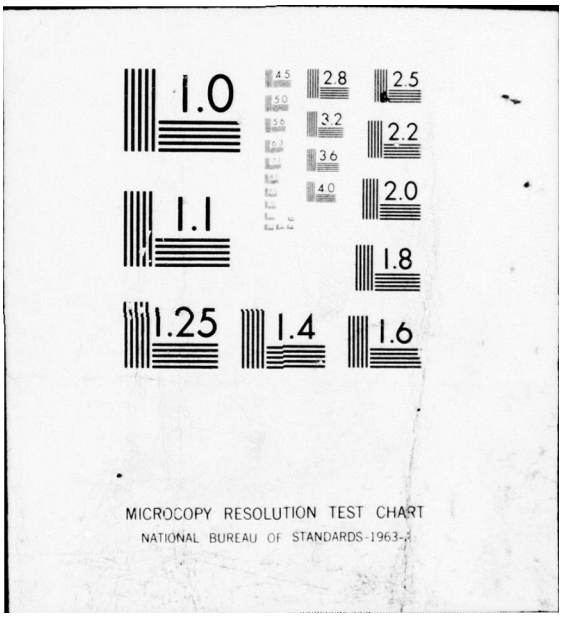


FIGURE 3-9 , SPECIMEN NO. 3 SHOT NO. 1 ,
STRAIN TIME HISTORY

AD-A052 029 BOEING WICHITA CO KS F/G 18/3
STRUCTURAL RESPONSE TO SIMULATED NUCLEAR OVERPRESSURE (STRESNO)--ETC(U)
MAR 77 R P SYRING, W D PIERSON DNA001-76-C-0084
UNCLASSIFIED D3-9788-5-VOL-2 DNA-4278F-2 NL

2 OF 8
AD A052 029




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-

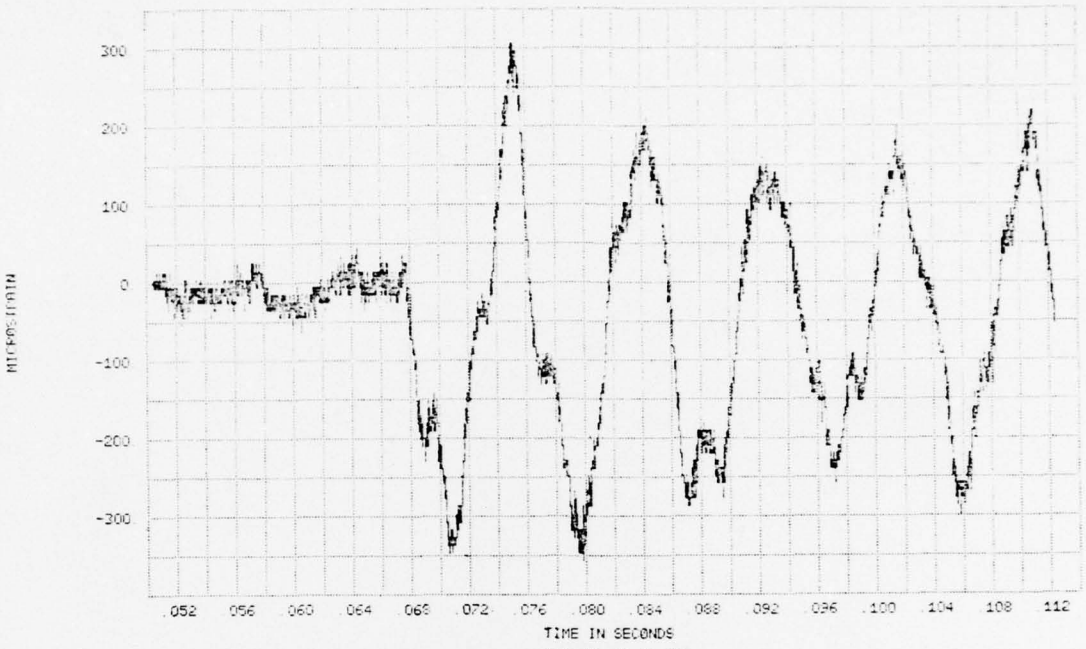


FIGURE 3-10 , SPECIMEN NO. 3 , SHOT NO. 1 , STRAIN TIME HISTORY

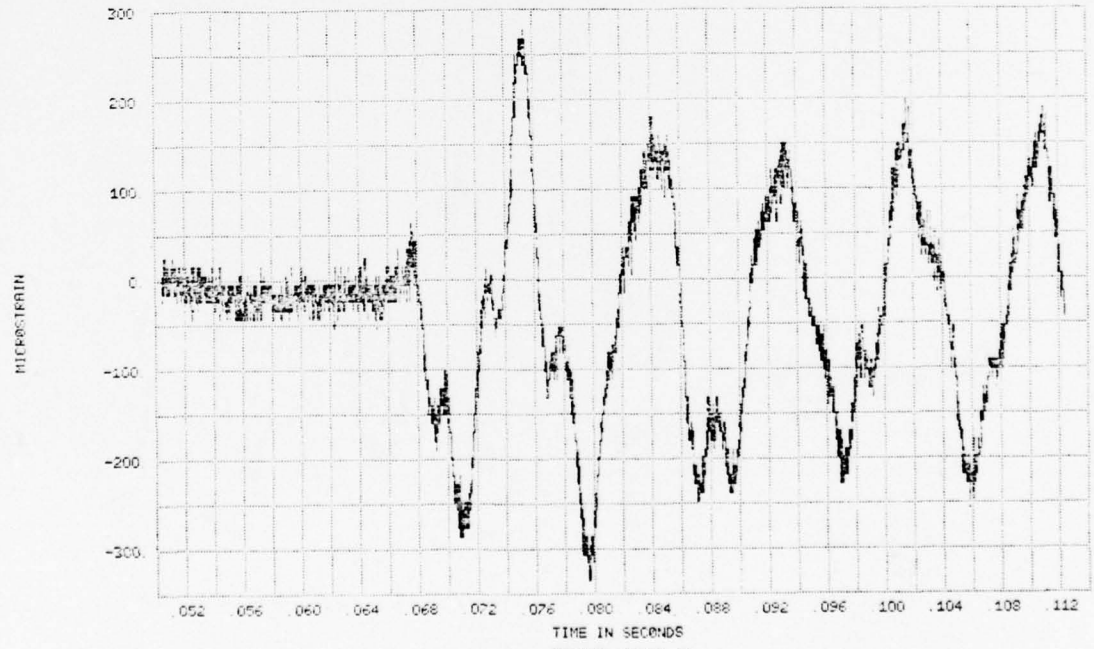


FIGURE 3-11 , SPECIMEN NO. 3 , SHOT NO. 1 , STRAIN TIME HISTORY

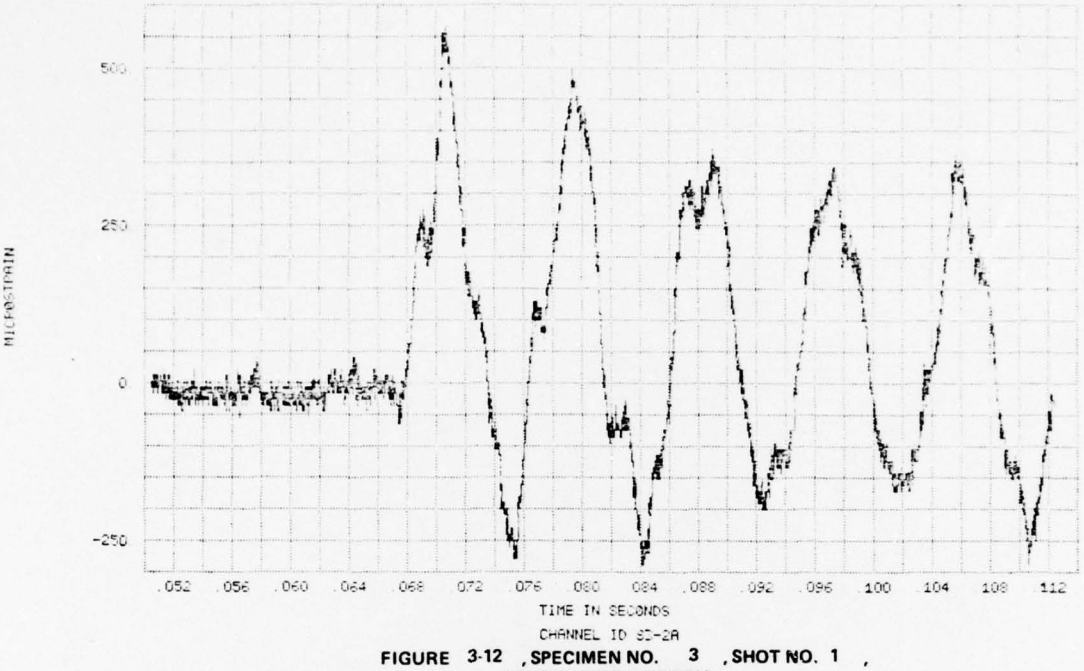


FIGURE 3-12 , SPECIMEN NO. 3 , SHOT NO. 1 ,
STRAIN TIME HISTORY

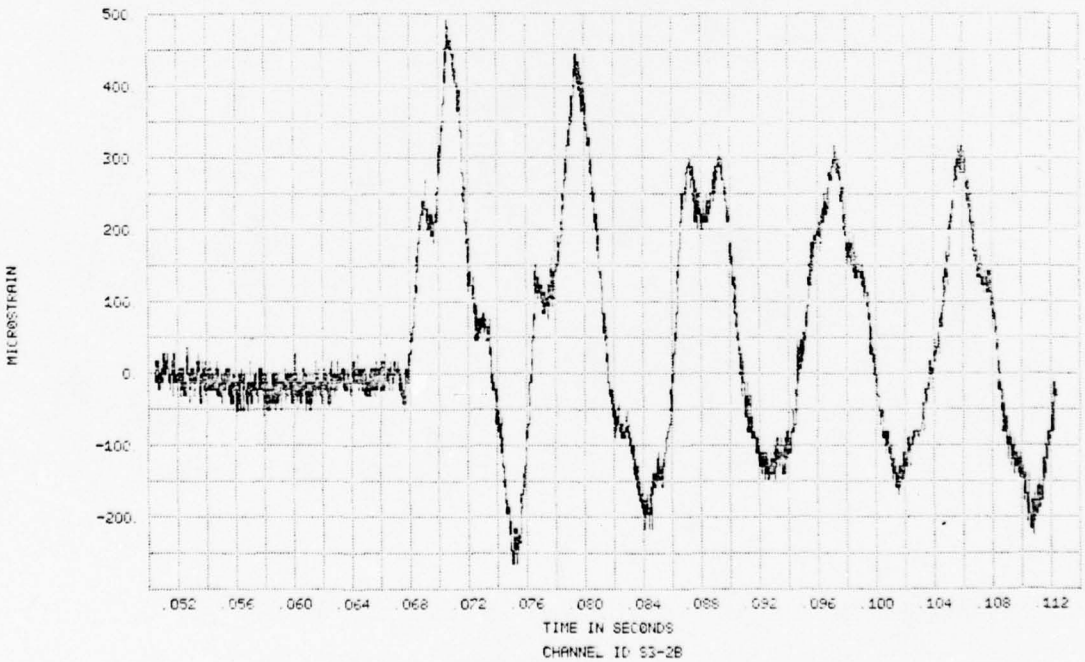


FIGURE 3-13 , SPECIMEN NO. 3 , SHOT NO. 1 ,
STRAIN TIME HISTORY

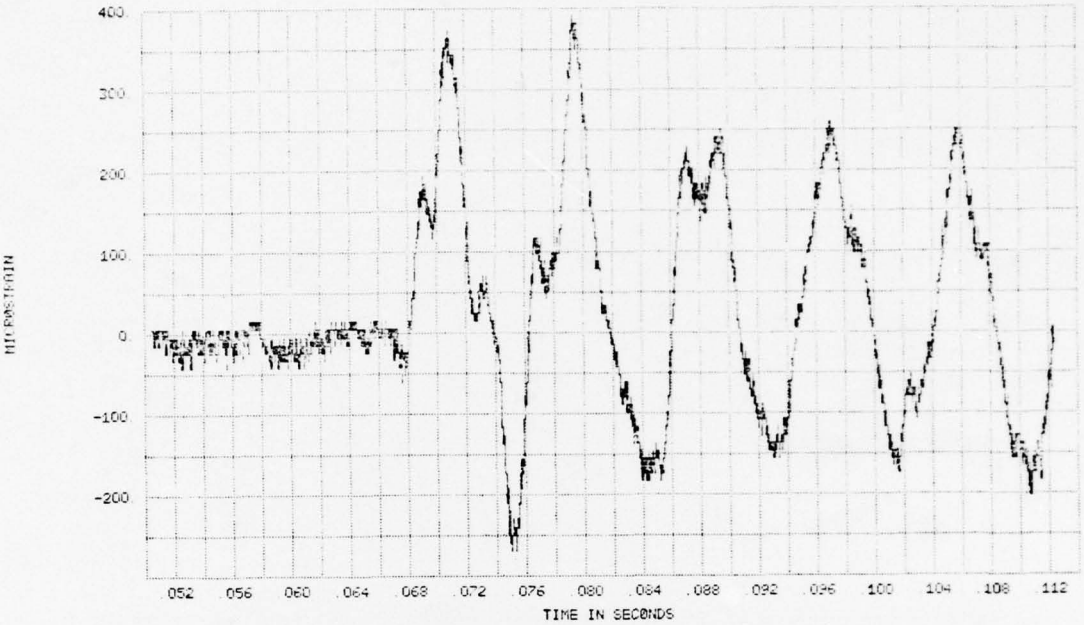


FIGURE 3-14 , SPECIMEN NO. 3 , SHOT NO. 1 , STRAIN TIME HISTORY

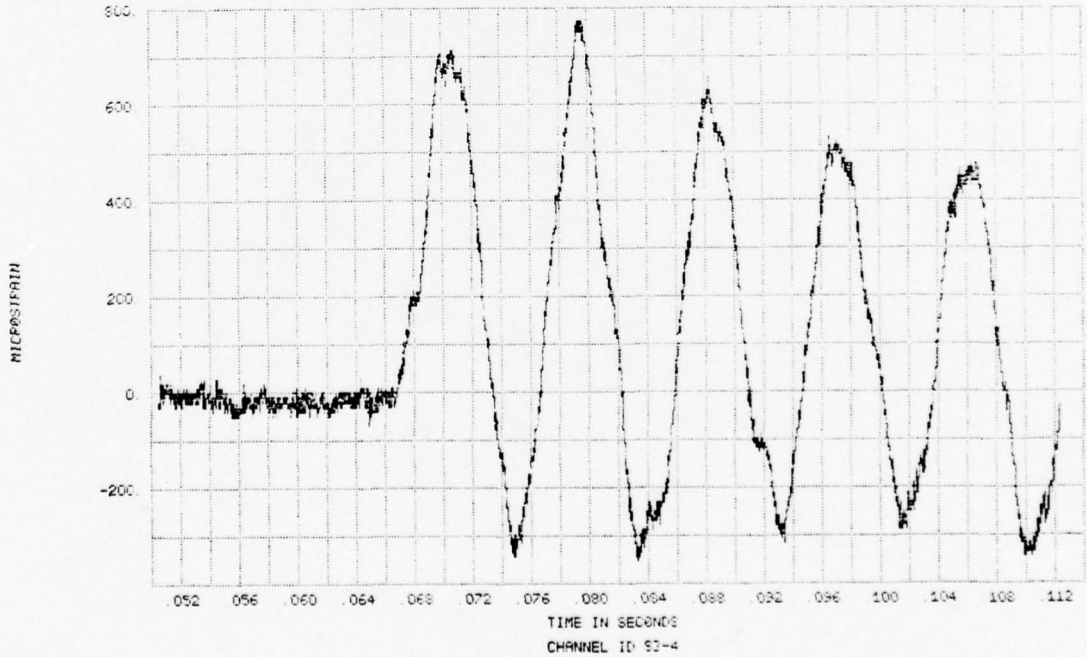


FIGURE 3-15 , SPECIMEN NO. 3 , SHOT NO. 1 , STRAIN TIME HISTORY

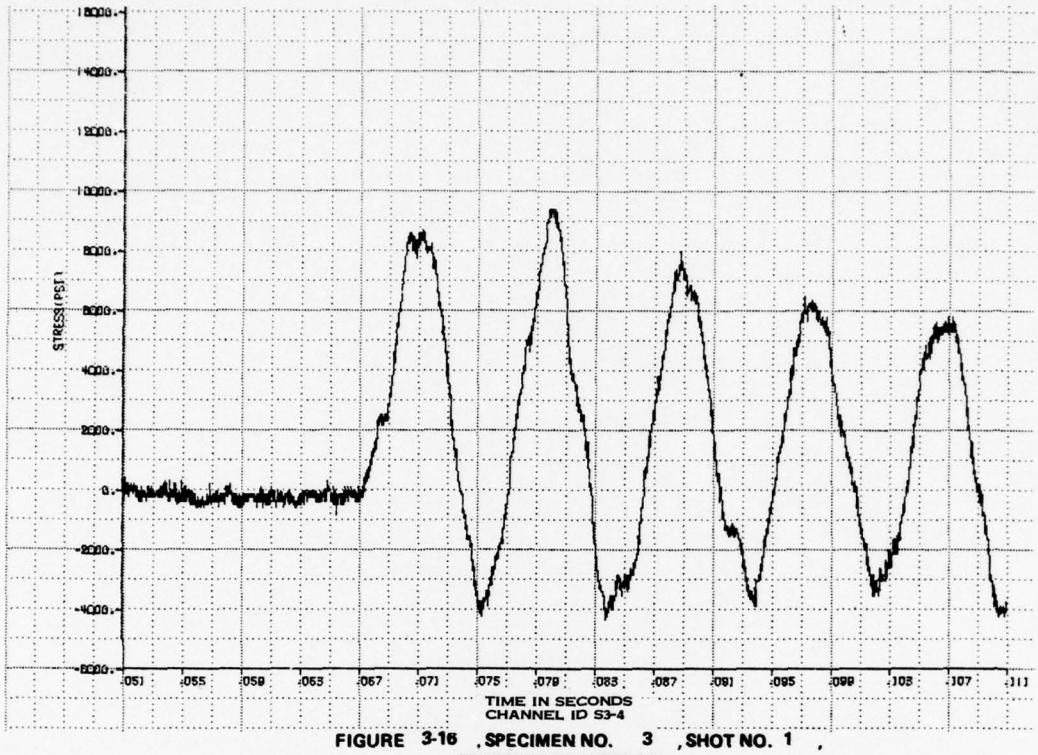


FIGURE 3-16 , SPECIMEN NO. 3 , SHOT NO. 1 ,
STRESS TIME HISTORY

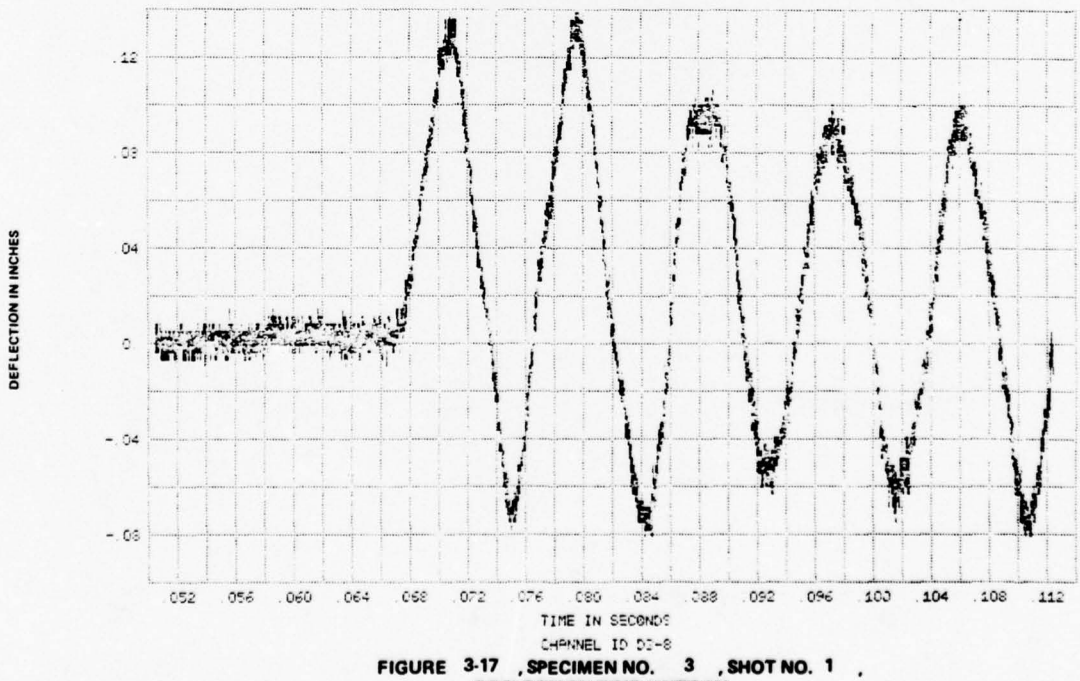


FIGURE 3-17 , SPECIMEN NO. 3 , SHOT NO. 1 ,
DEFLECTION TIME HISTORY

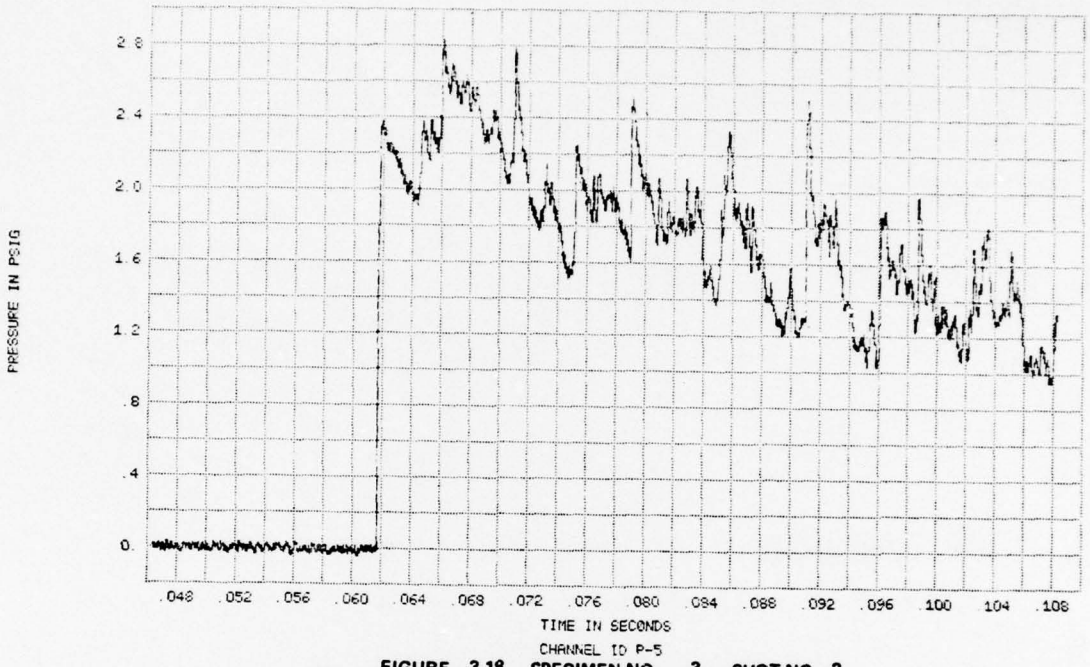


FIGURE 3-18 , SPECIMEN NO. 3 , SHOT NO. 2 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

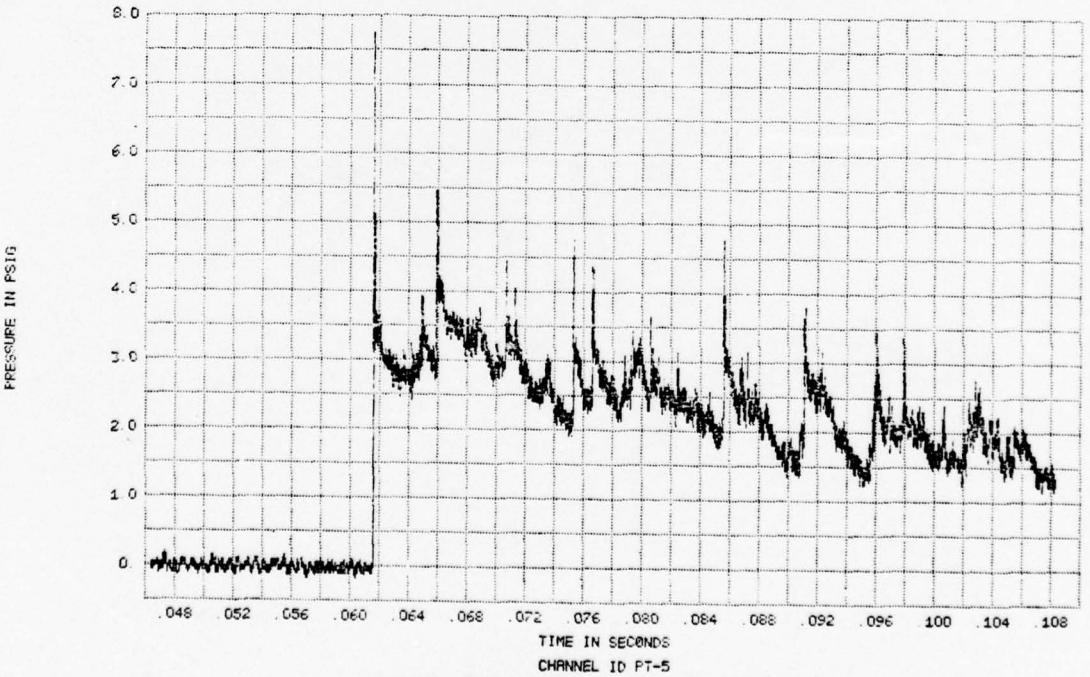


FIGURE 3-19 . SPECIMEN NO. 3 , SHOT NO. 2 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

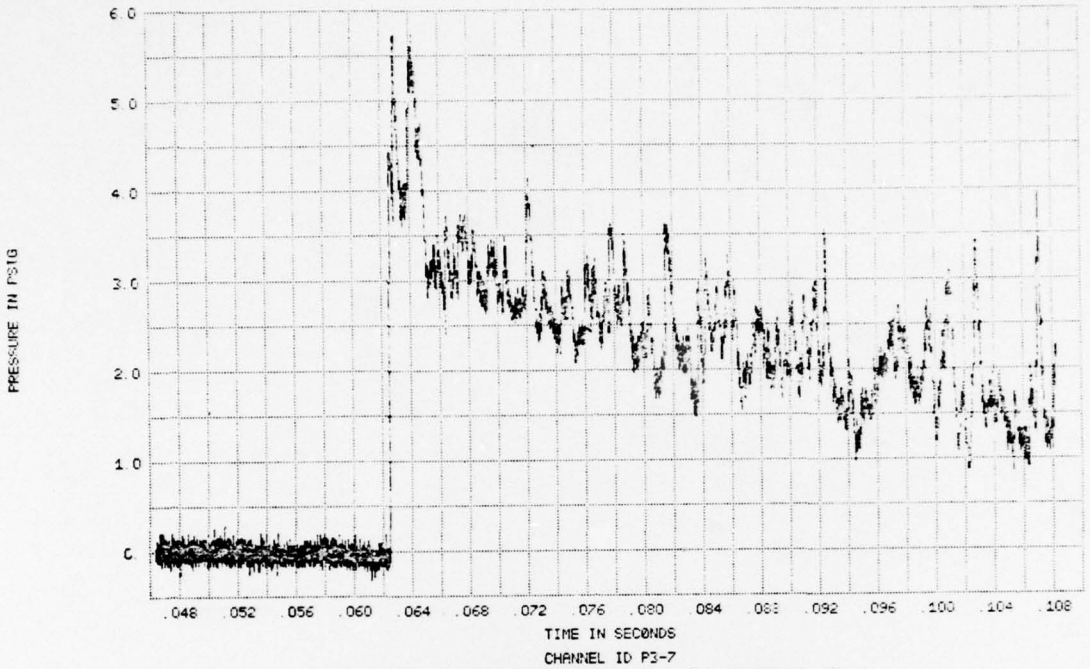


FIGURE 3-20 , SPECIMEN NO. 3 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

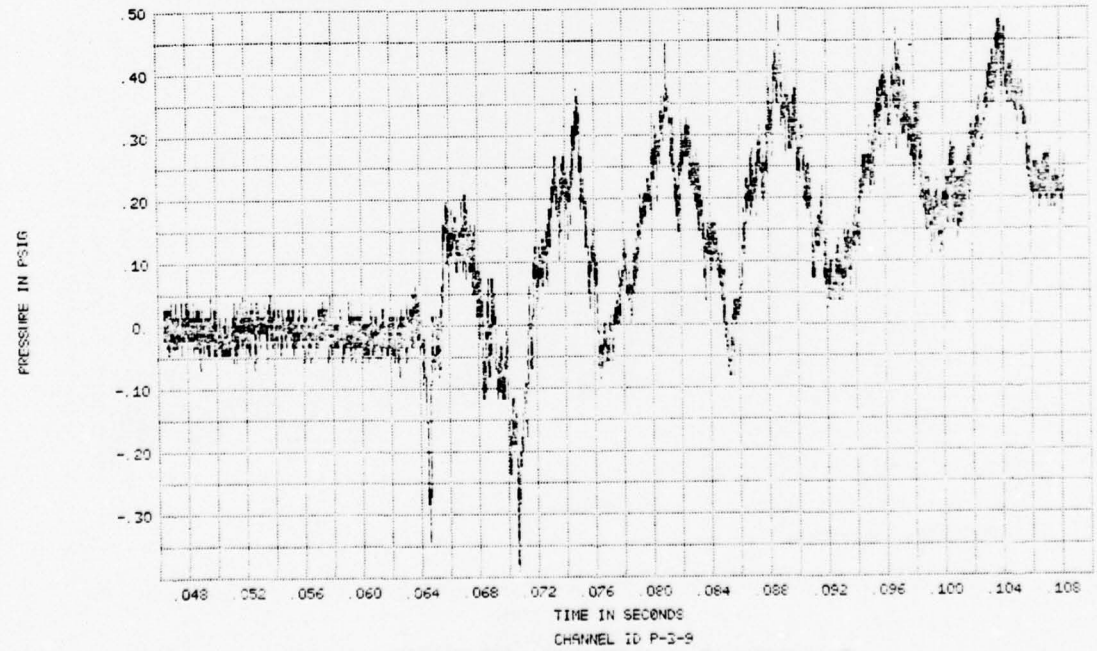


FIGURE 3-21 , SPECIMEN NO. 3 , SHOT NO. 2 ,
INTERNAL PRESSURE TIME HISTORY

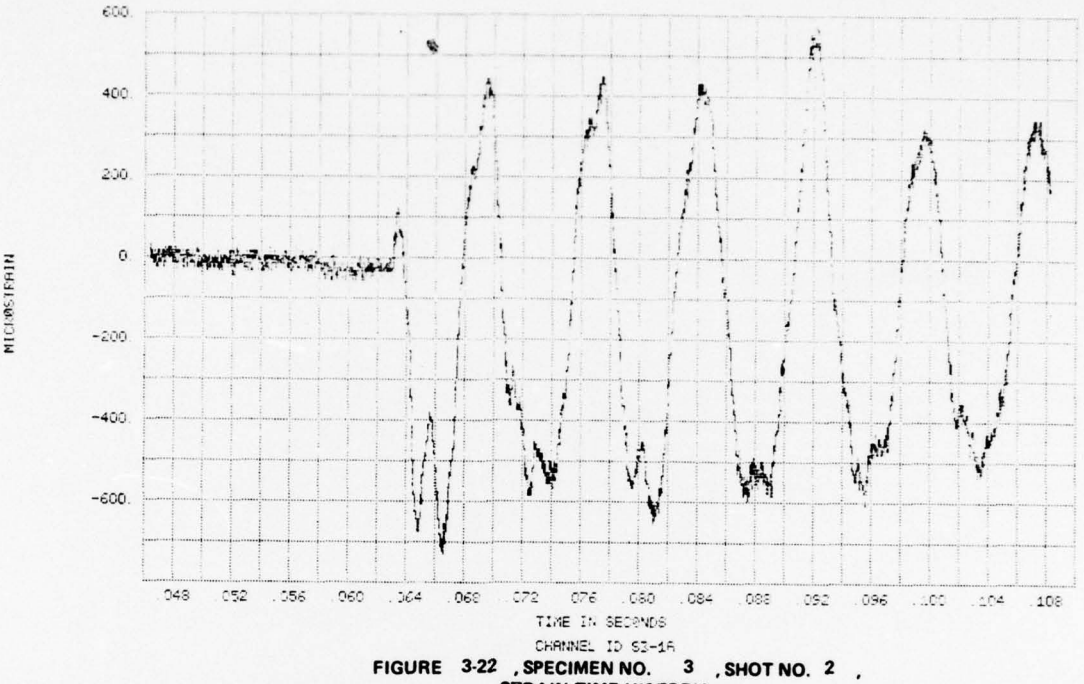


FIGURE 3-22 , SPECIMEN NO. 3 , SHOT NO. 2 , STRAIN TIME HISTORY

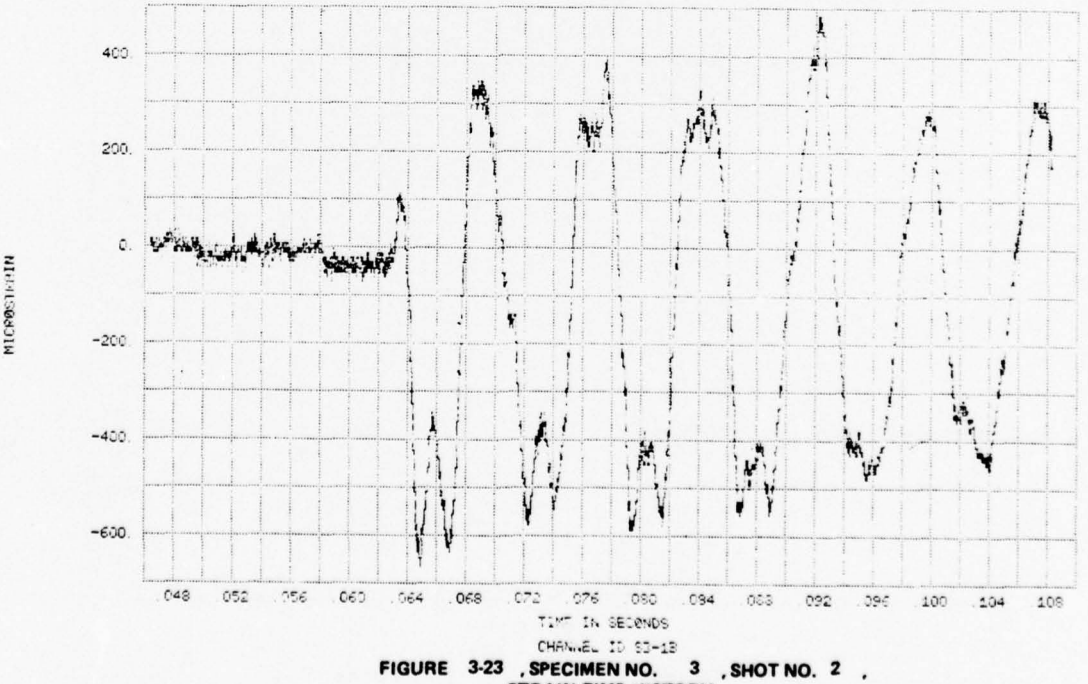


FIGURE 3-23 , SPECIMEN NO. 3 , SHOT NO. 2 , STRAIN TIME HISTORY

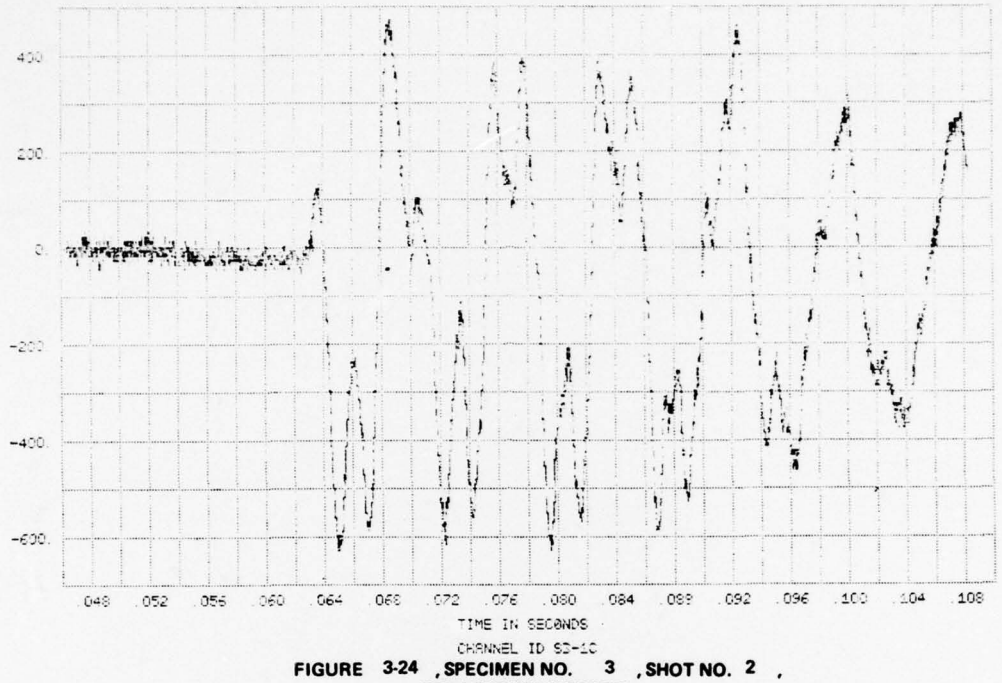


FIGURE 3-24 , SPECIMEN NO. 3 , SHOT NO. 2 ,
STRAIN TIME HISTORY

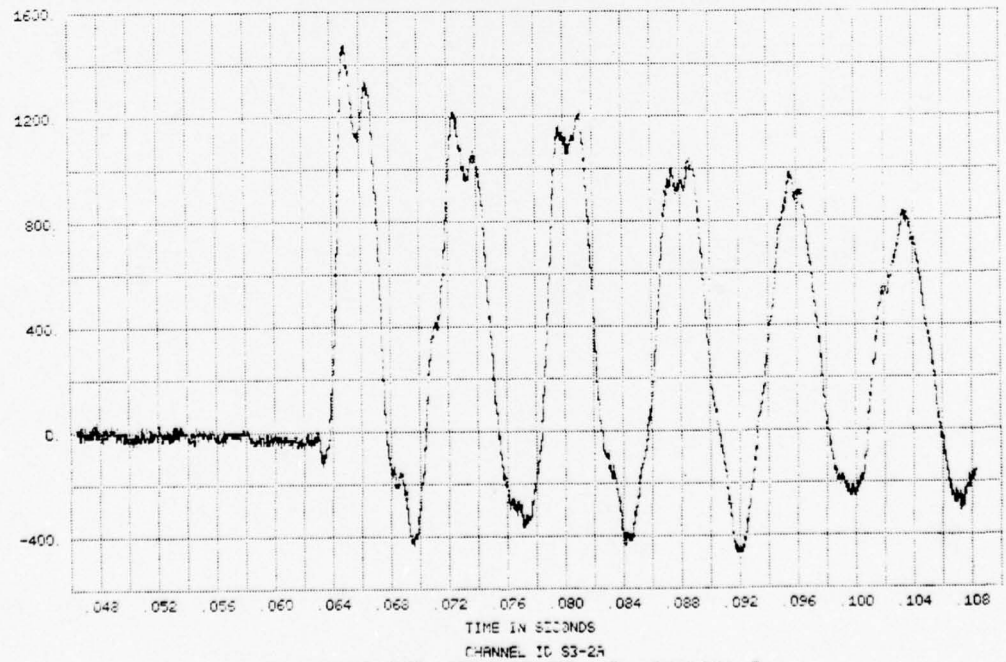


FIGURE 3-25 , SPECIMEN NO. 3 , SHOT NO. 2 ,
STRAIN TIME HISTORY

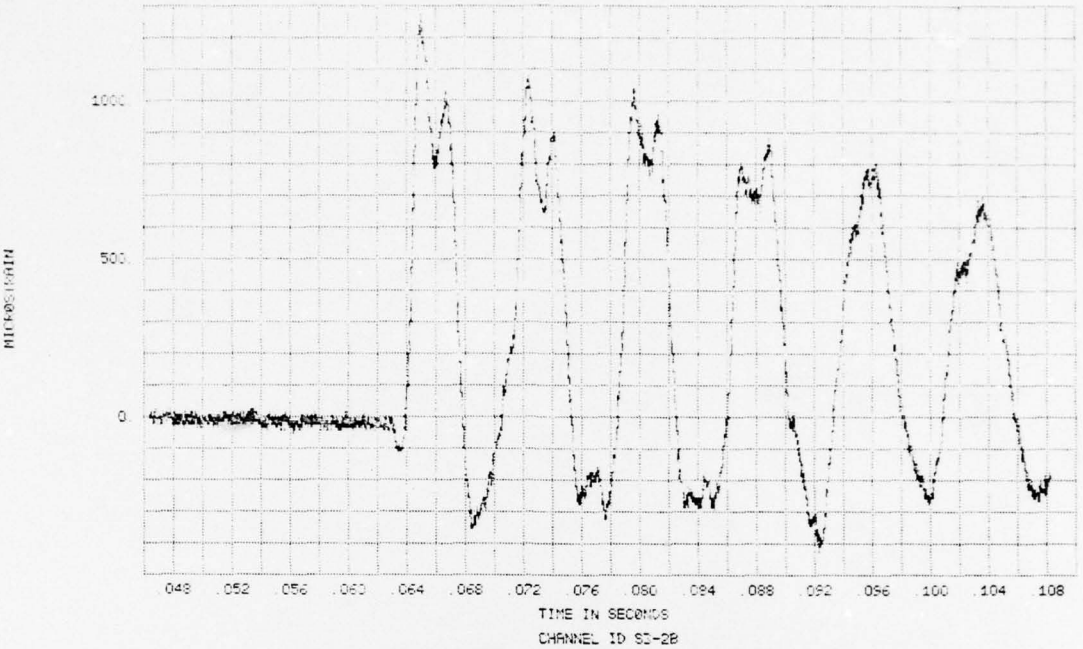


FIGURE 3-26 , SPECIMEN NO. 3 , SHOT NO. 2 ,
STRAIN TIME HISTORY

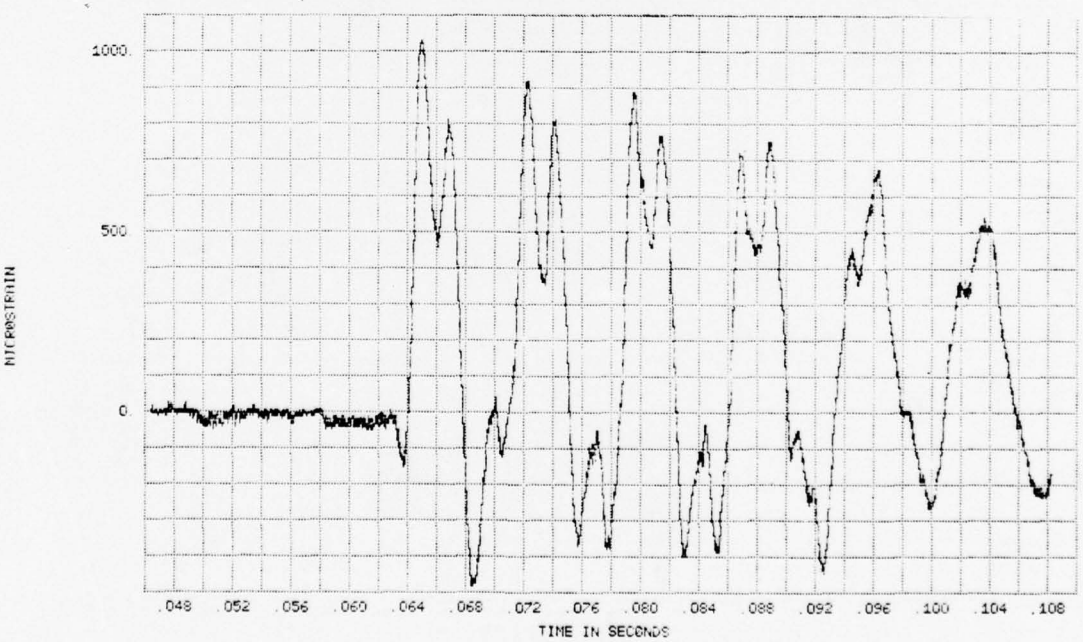


FIGURE 3-27 , SPECIMEN NO. 3 , SHOT NO. 2 ,
STRAIN TIME HISTORY

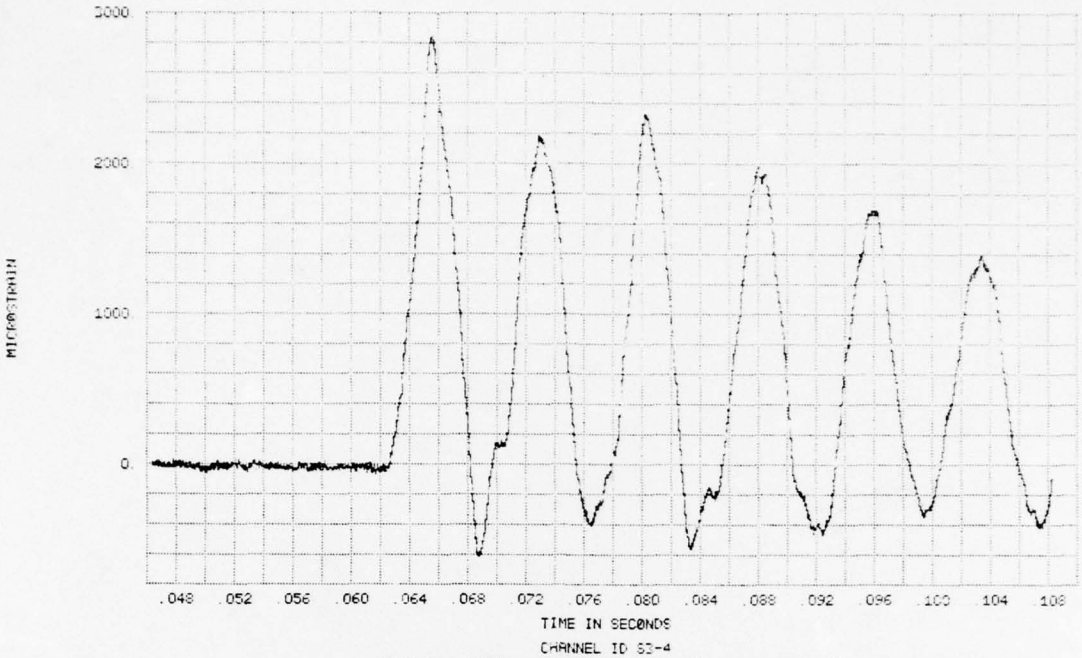


FIGURE 3-28 , SPECIMEN NO. 3 , SHOT NO. 2 ,
STRAIN TIME HISTORY

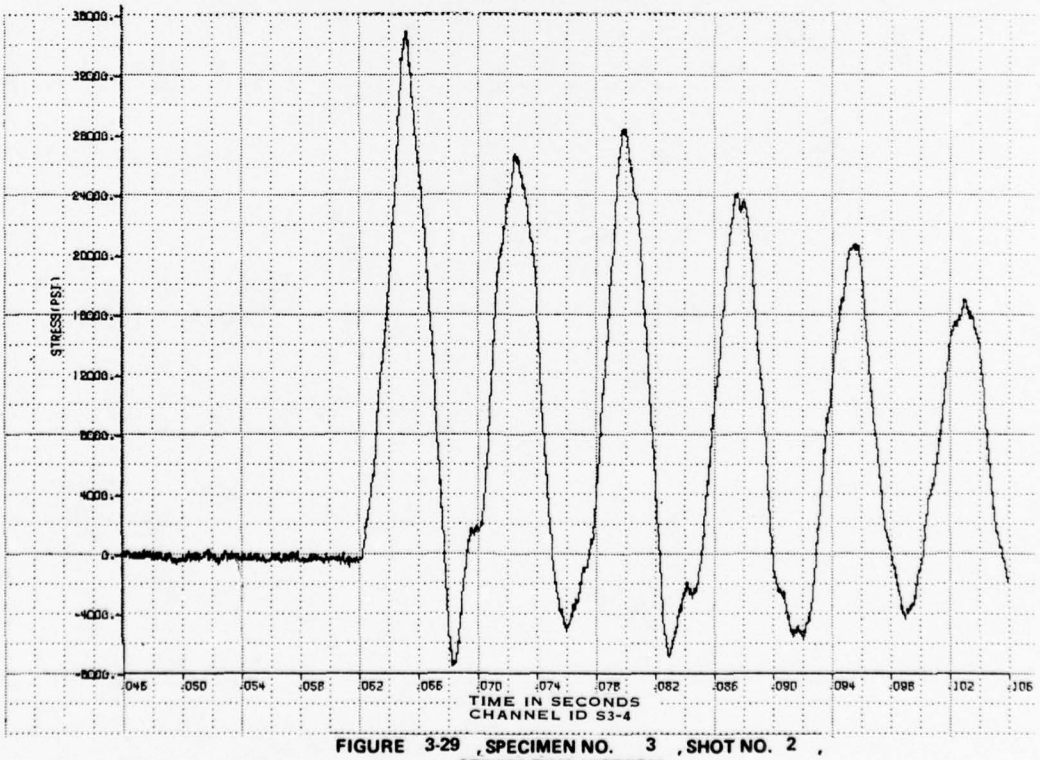


FIGURE 3-29 , SPECIMEN NO. 3 , SHOT NO. 2 ,
STRESS TIME HISTORY

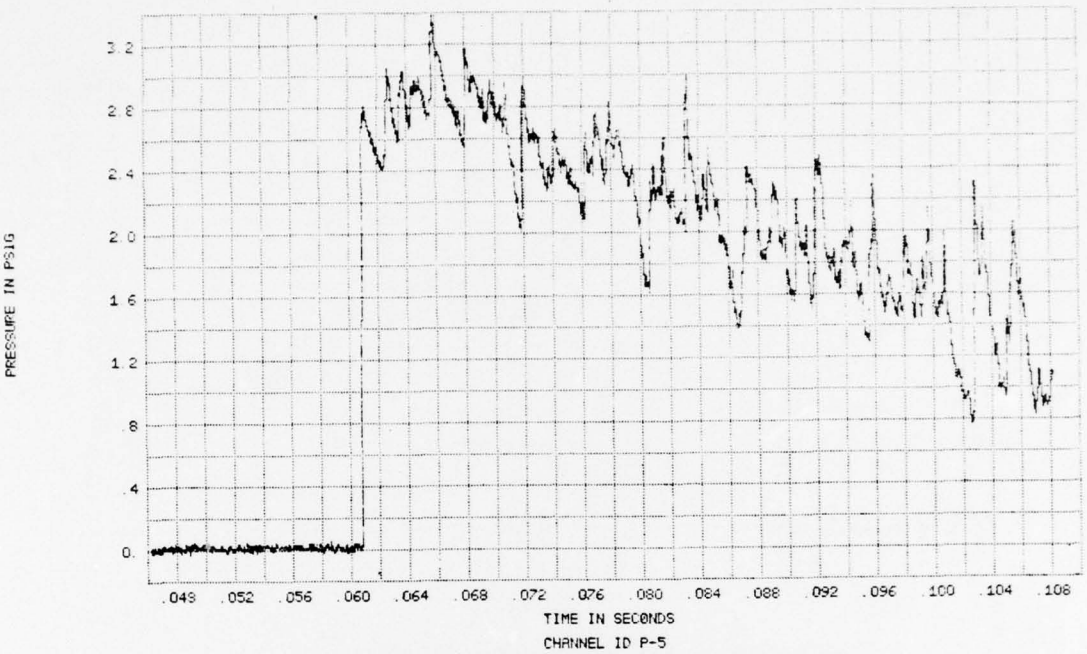


FIGURE 3-30 , SPECIMEN NO. 3 , SHOT NO. 3 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

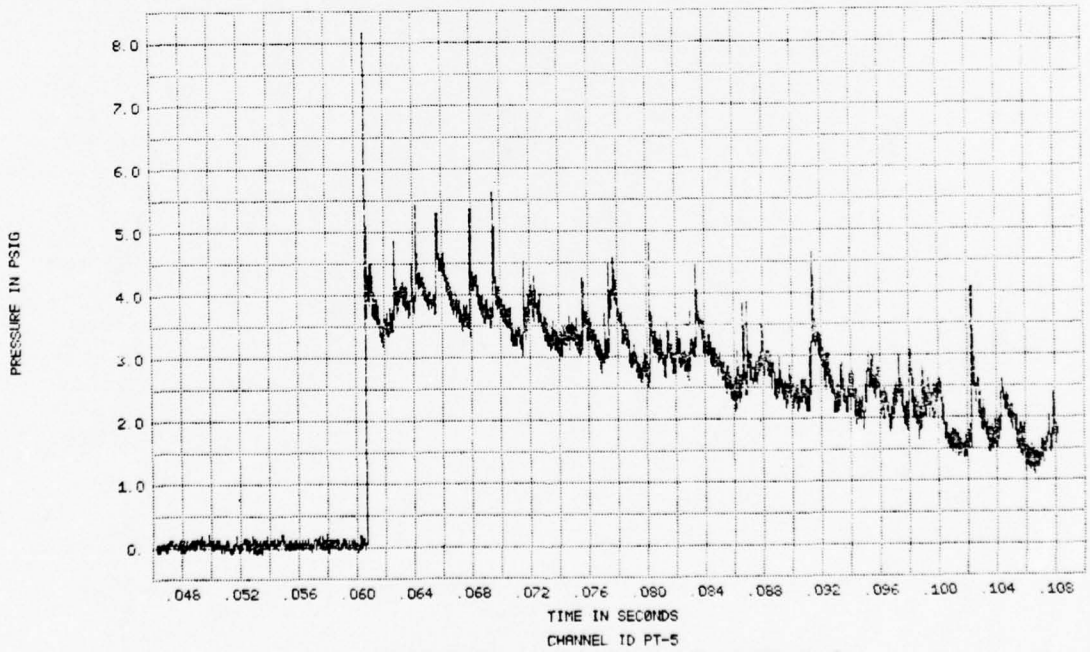


FIGURE 3-31 , SPECIMEN NO. 3 , SHOT NO. 3 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

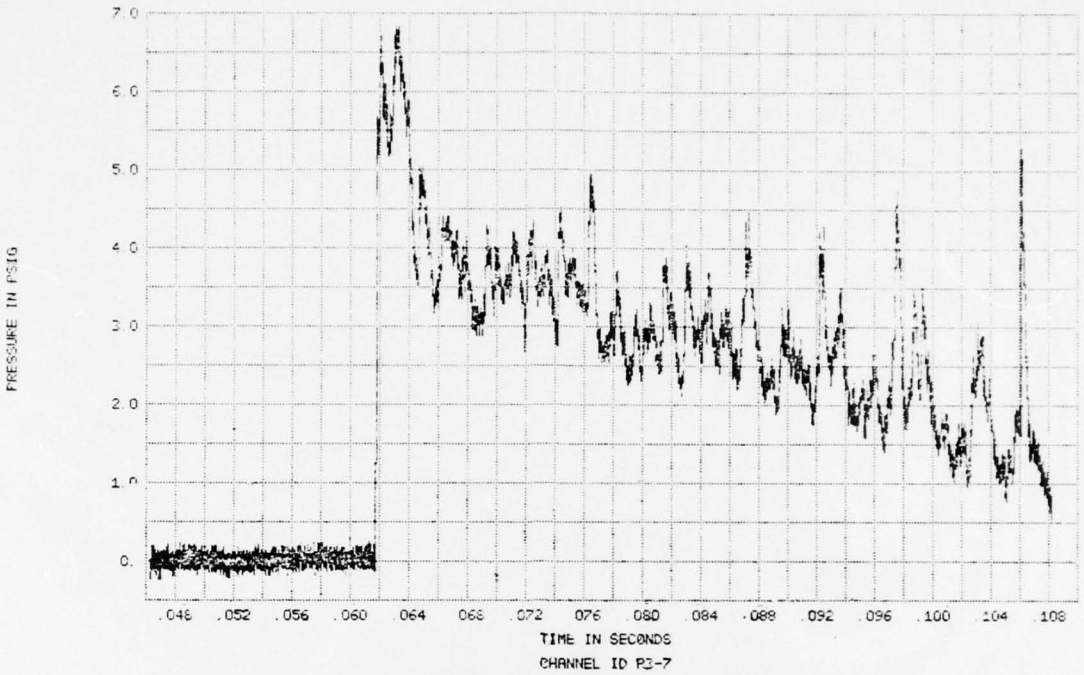


FIGURE 3-32 , SPECIMEN NO. 3 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

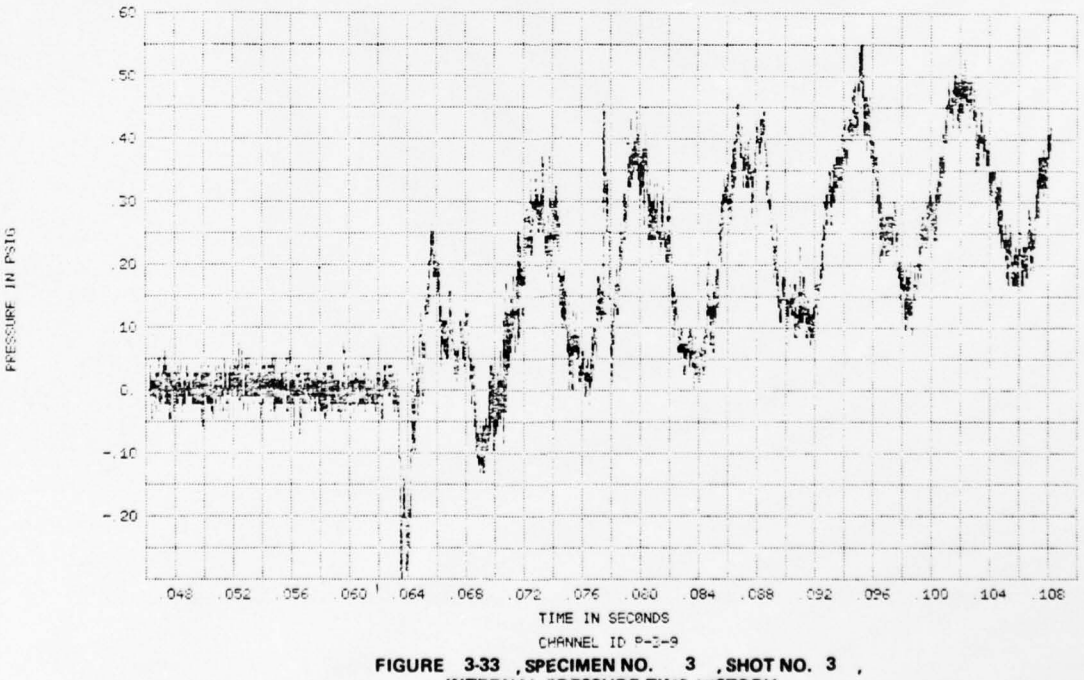


FIGURE 3-33 , SPECIMEN NO. 3 , SHOT NO. 3 ,
INTERNAL PRESSURE TIME HISTORY

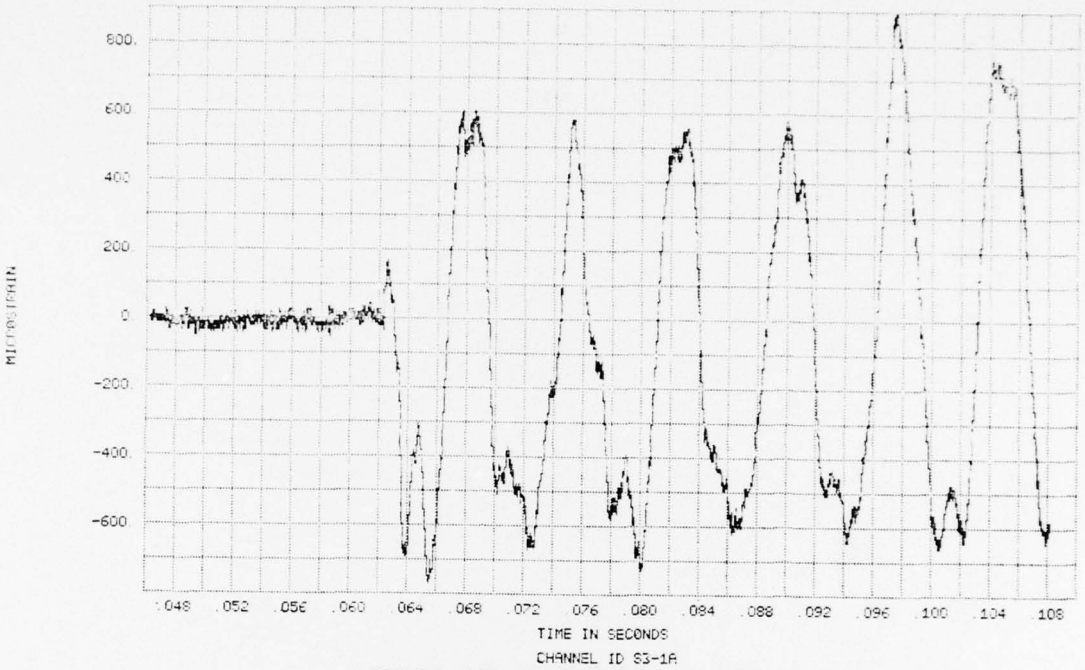


FIGURE 3-34 , SPECIMEN NO. 3 , SHOT NO. 3 ,
STRAIN TIME HISTORY

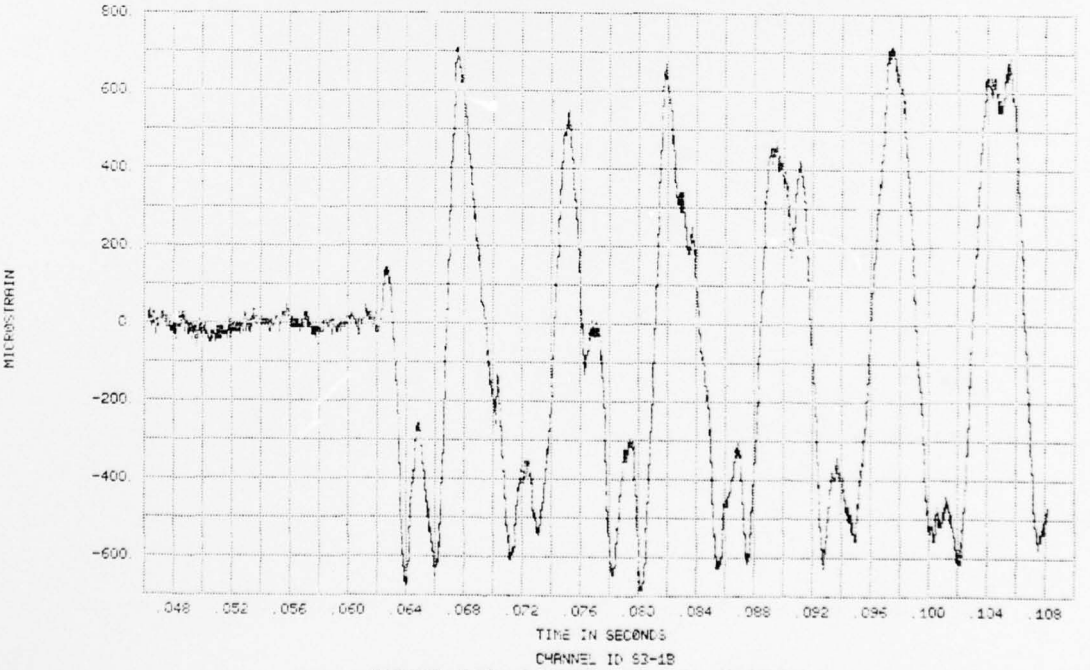


FIGURE 3-35 , SPECIMEN NO. 3 , SHOT NO. 3 ,
STRAIN TIME HISTORY

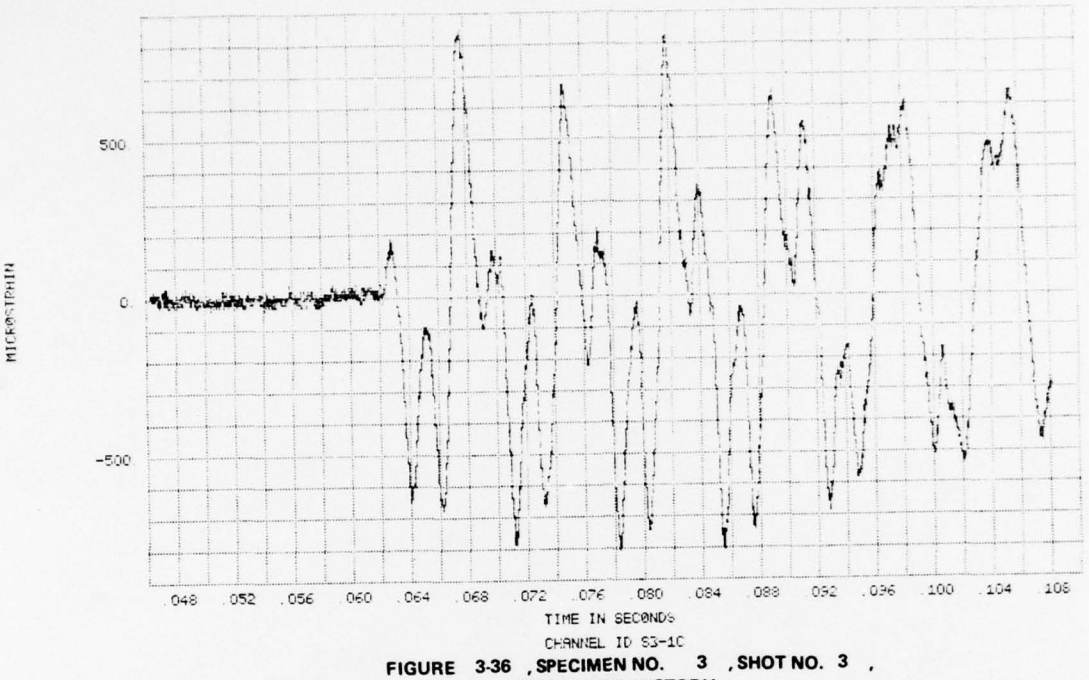


FIGURE 3-36 , SPECIMEN NO. 3 , SHOT NO. 3 , STRAIN TIME HISTORY

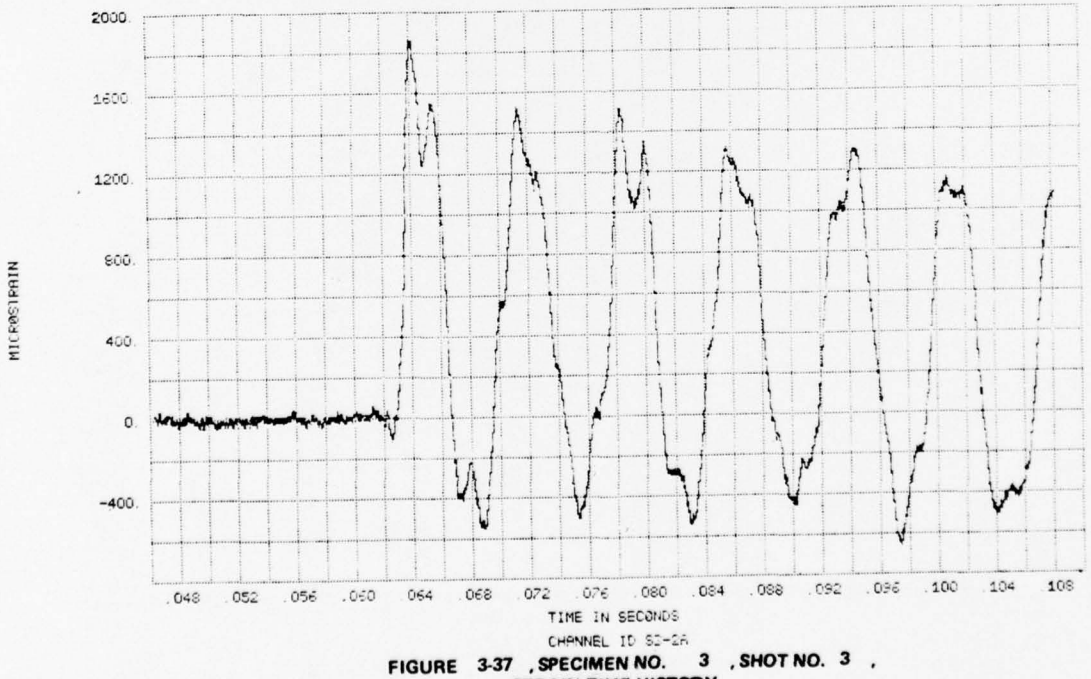


FIGURE 3-37 , SPECIMEN NO. 3 , SHOT NO. 3 , STRAIN TIME HISTORY

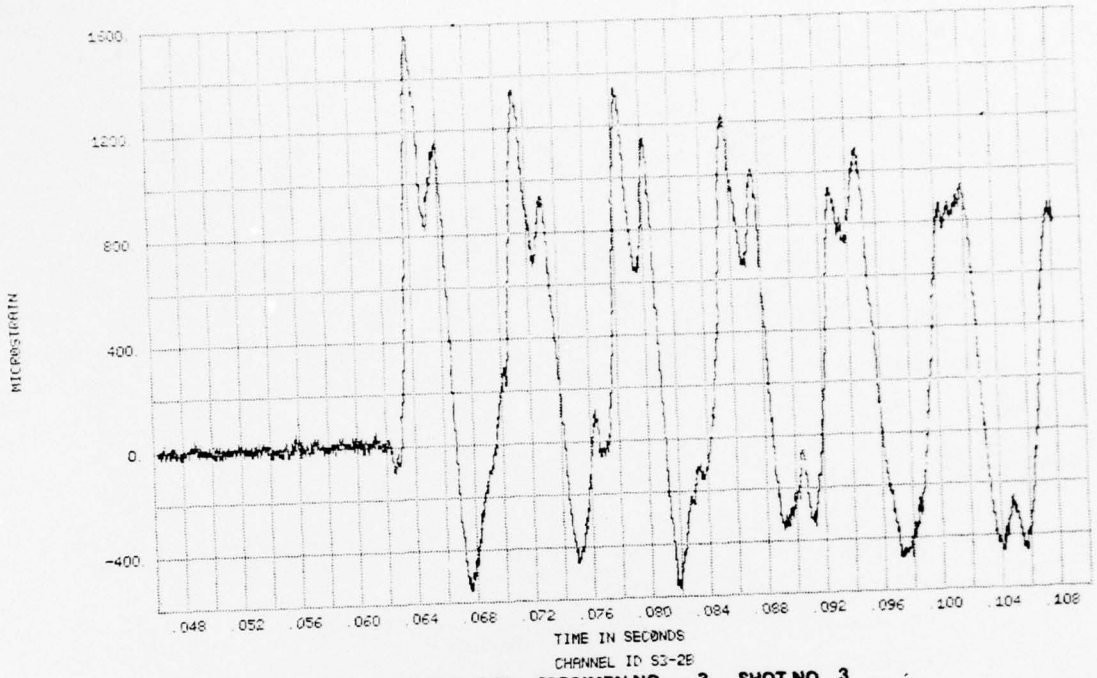


FIGURE 3-38 , SPECIMEN NO. 3 , SHOT NO. 3 .
STRAIN TIME HISTORY

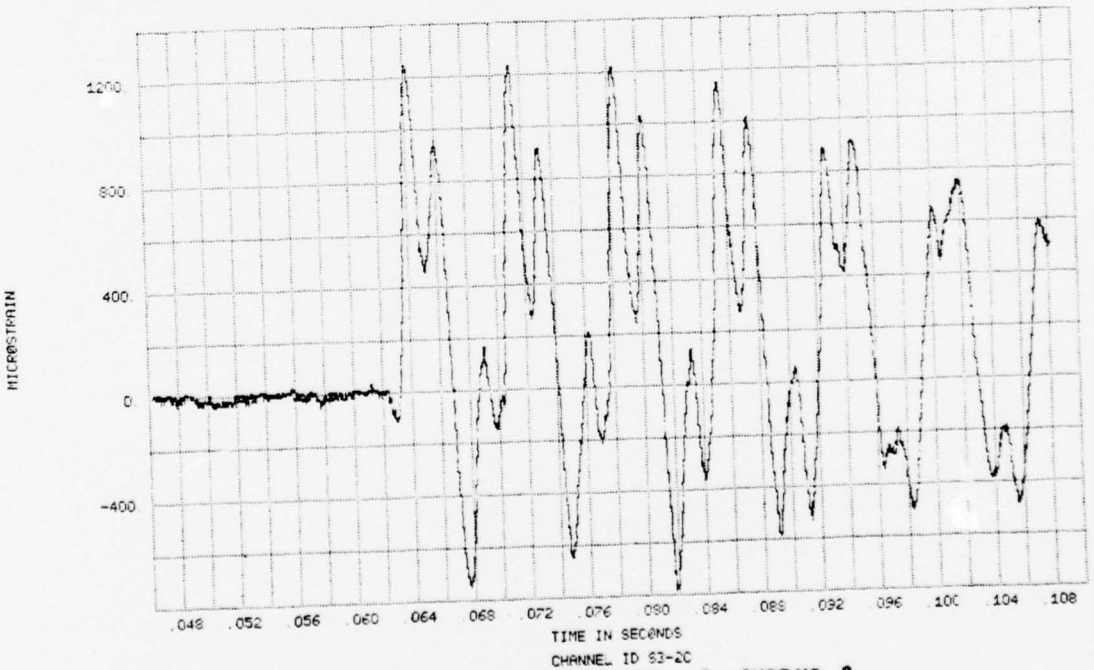


FIGURE 3-39 , SPECIMEN NO. 3 , SHOT NO. 3 .
STRAIN TIME HISTORY

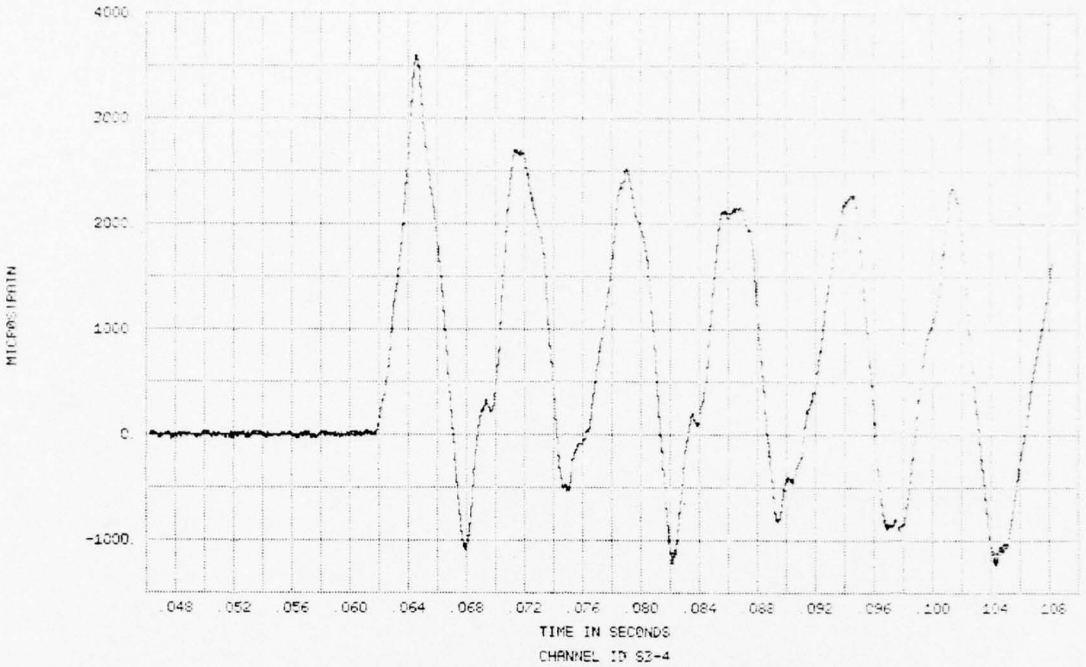


FIGURE 3-40 , SPECIMEN NO. 3 , SHOT NO. 3 , STRAIN TIME HISTORY

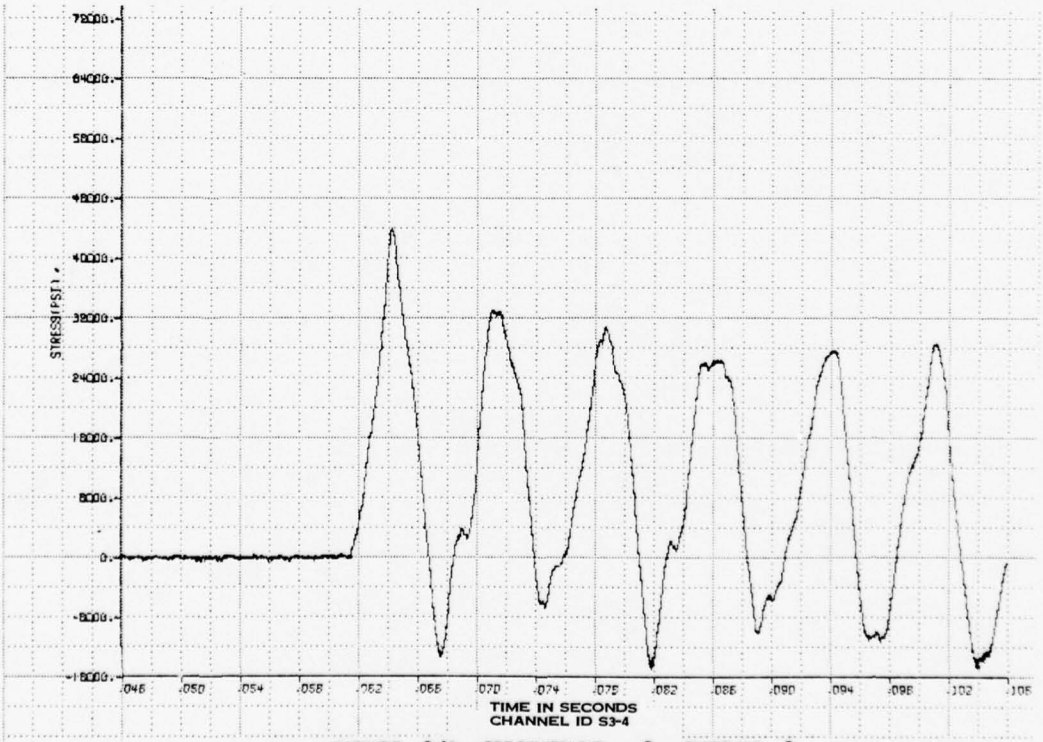


FIGURE 3-41 , SPECIMEN NO. 3 , SHOT NO. 3 , STRESS TIME HISTORY

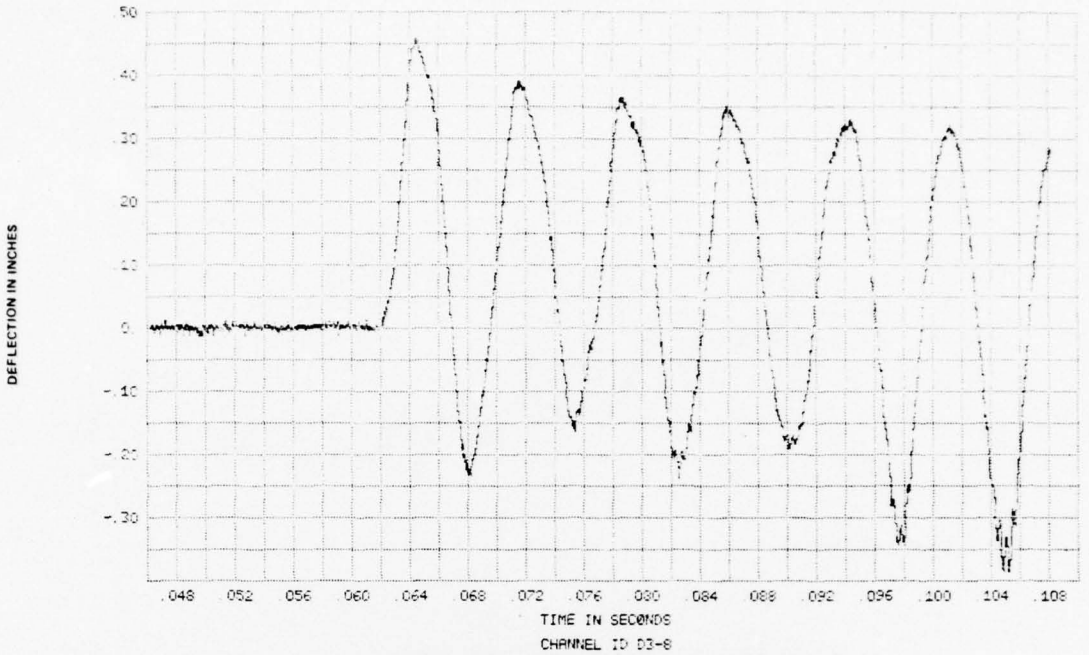


FIGURE 3-42 , SPECIMEN NO. 3 , SHOT NO. 3
DEFLECTION TIME HISTORY

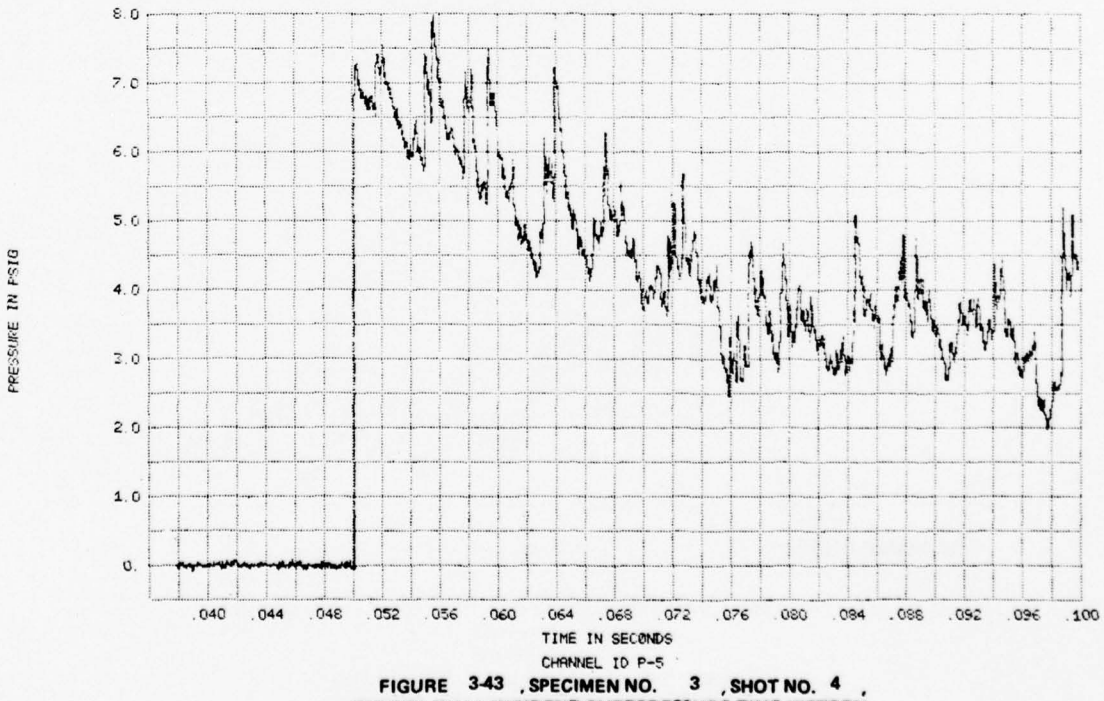


FIGURE 3-43 , SPECIMEN NO. 3 , SHOT NO. 4 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

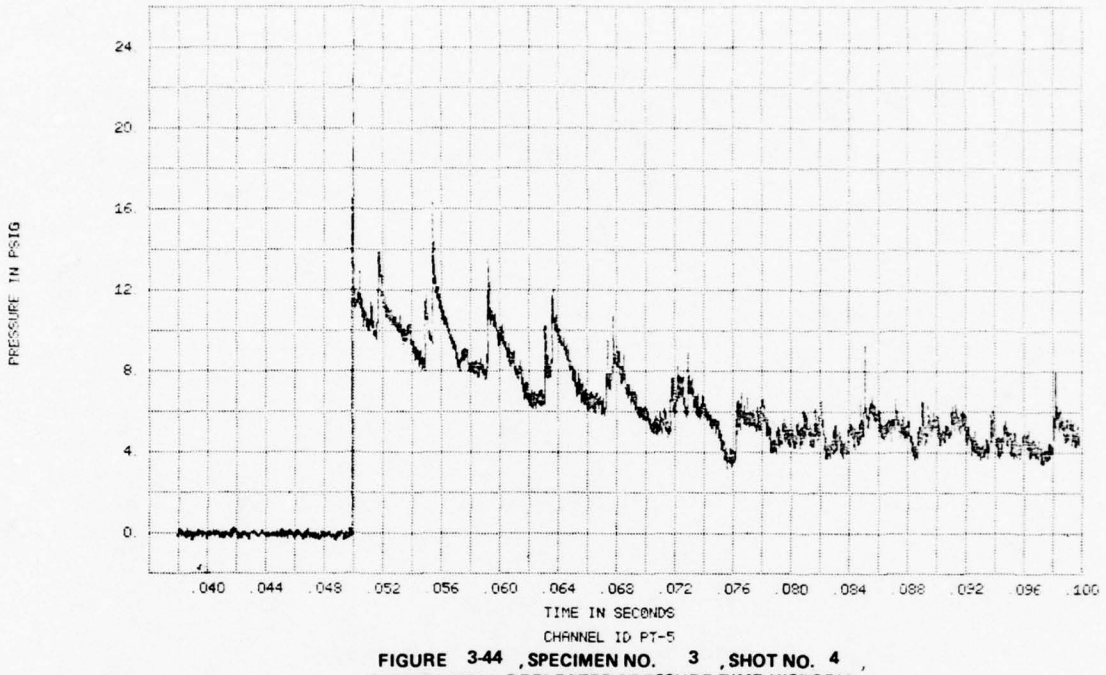


FIGURE 3-44 , SPECIMEN NO. 3 , SHOT NO. 4 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

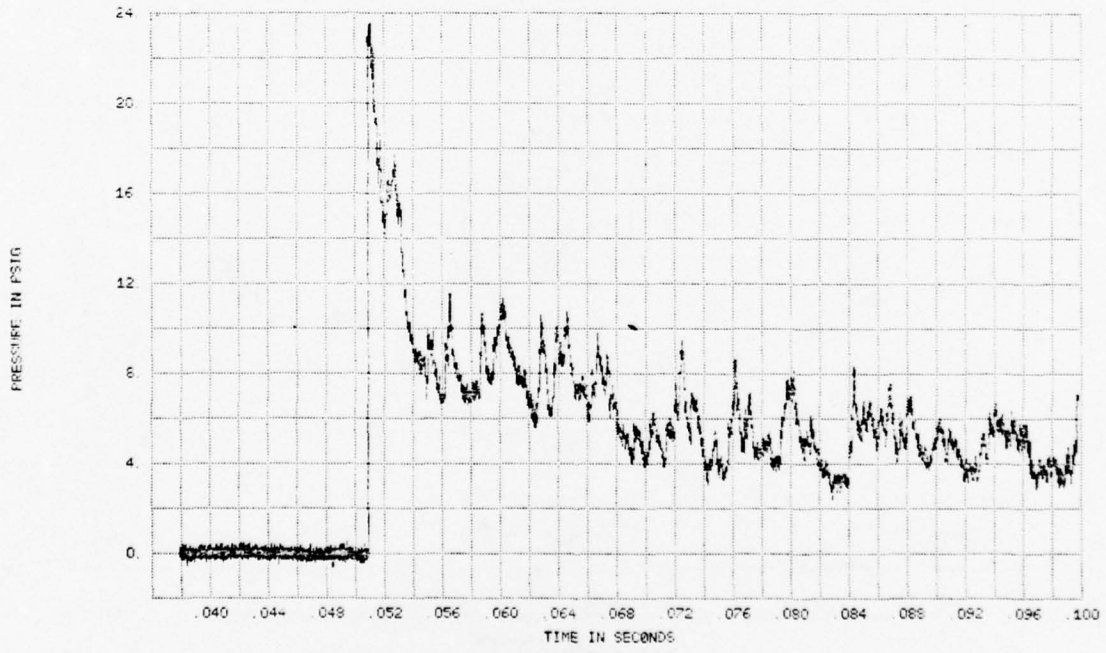


FIGURE 3-45 , SPECIMEN NO. 3 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

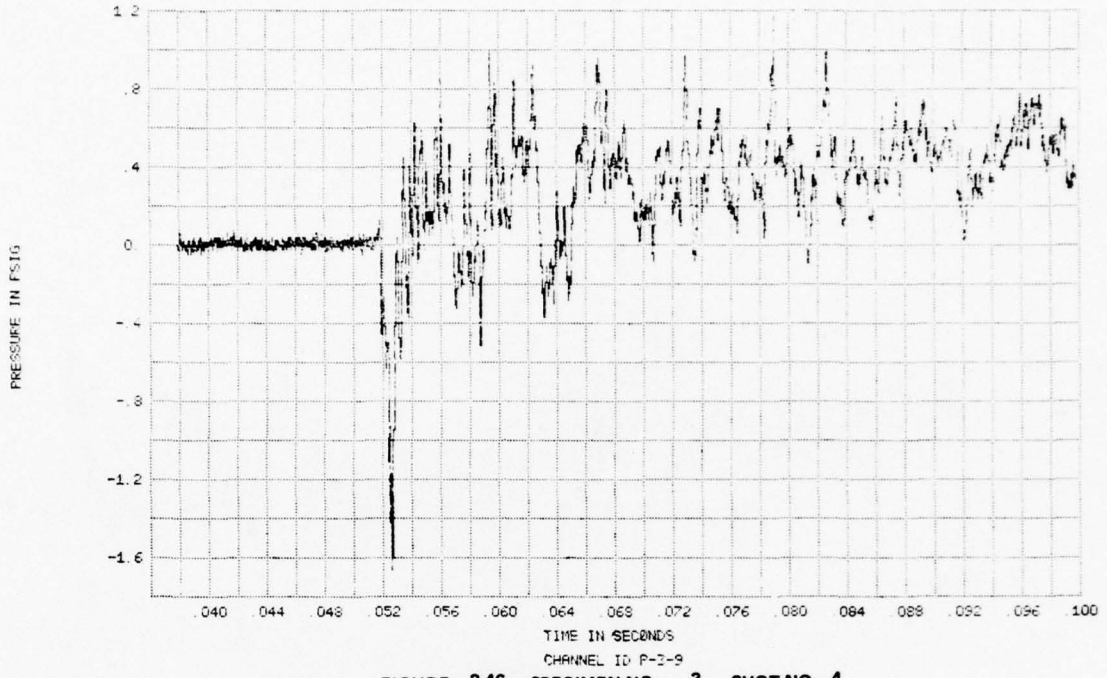


FIGURE 3-46 , SPECIMEN NO. 3 , SHOT NO. 4 ,
INTERNAL PRESSURE TIME HISTORY

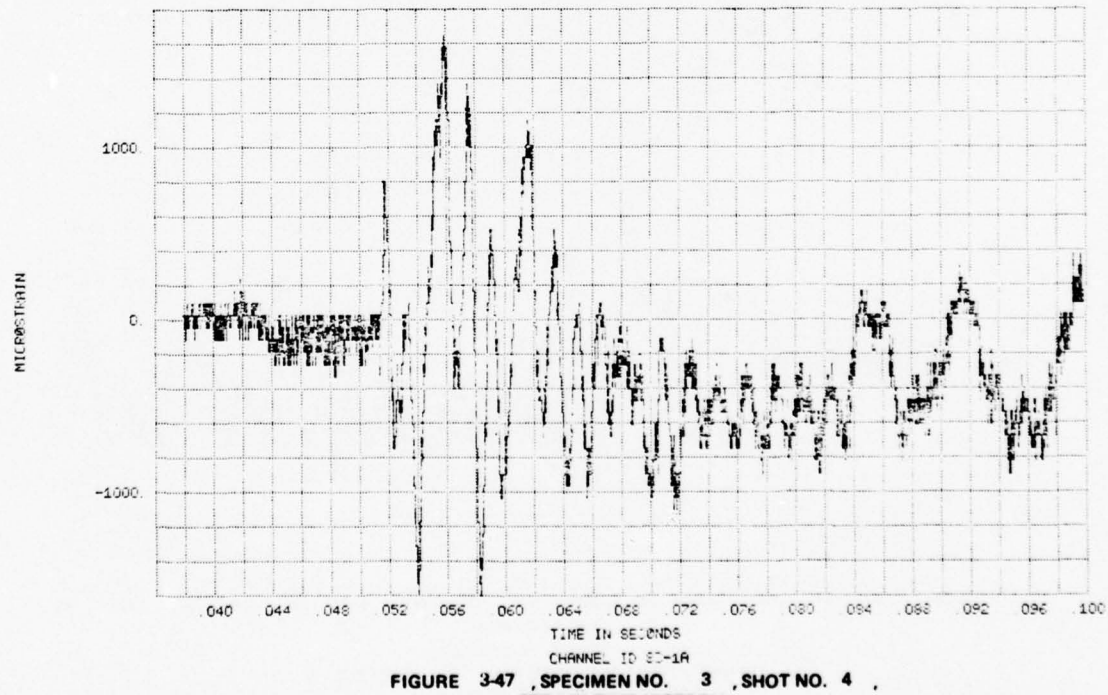


FIGURE 3-47 , SPECIMEN NO. 3 , SHOT NO. 4 ,
STRAIN TIME HISTORY

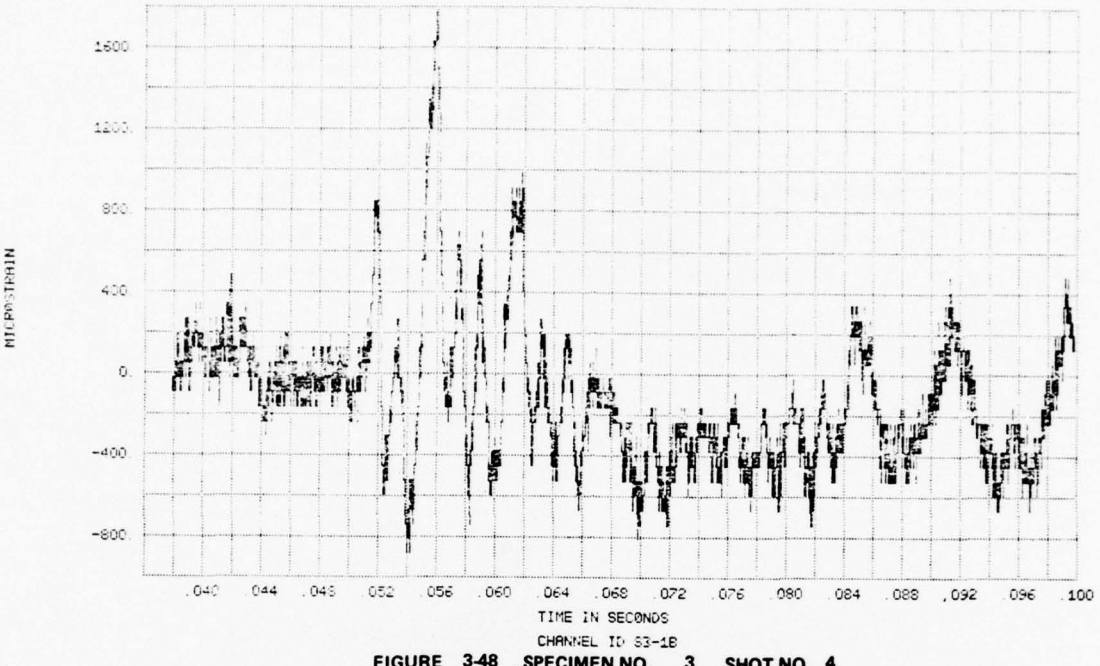


FIGURE 3-48 , SPECIMEN NO. 3 , SHOT NO. 4 , STRAIN TIME HISTORY

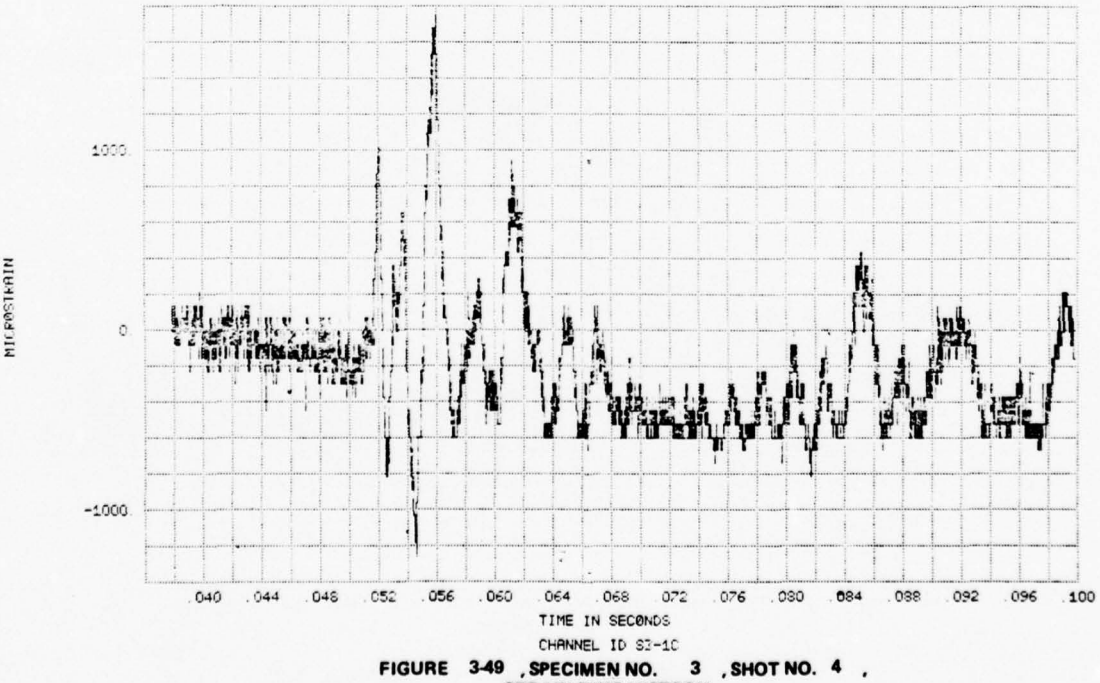


FIGURE 3-49 , SPECIMEN NO. 3 , SHOT NO. 4 , STRAIN TIME HISTORY

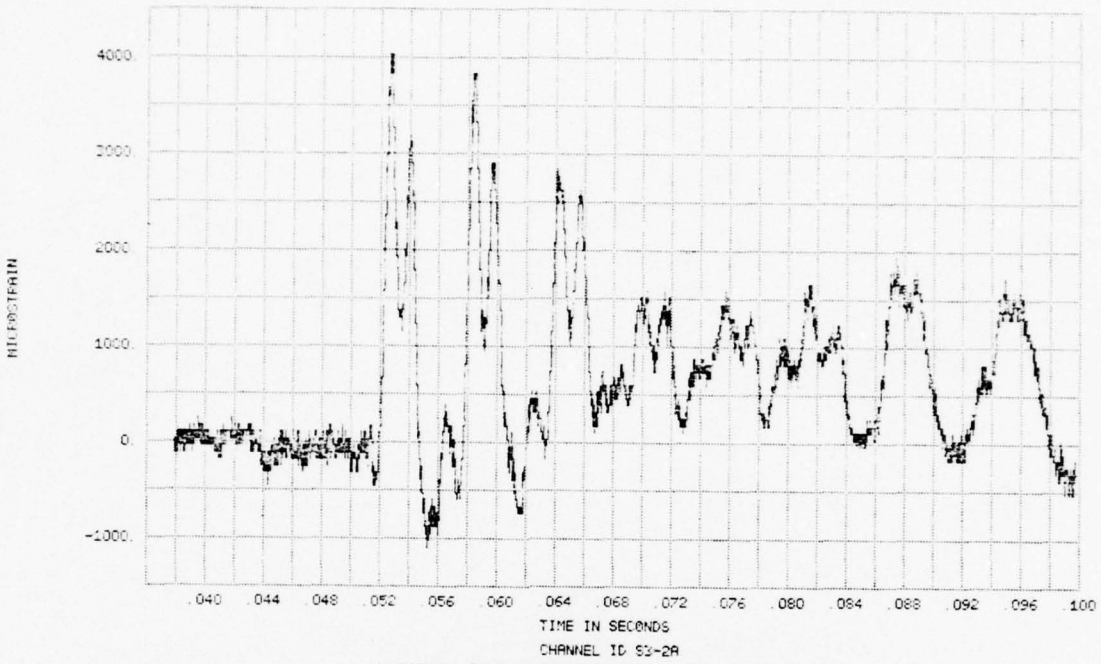


FIGURE 3-50 , SPECIMEN NO. 3 , SHOT NO. 4 ,
STRAIN TIME HISTORY

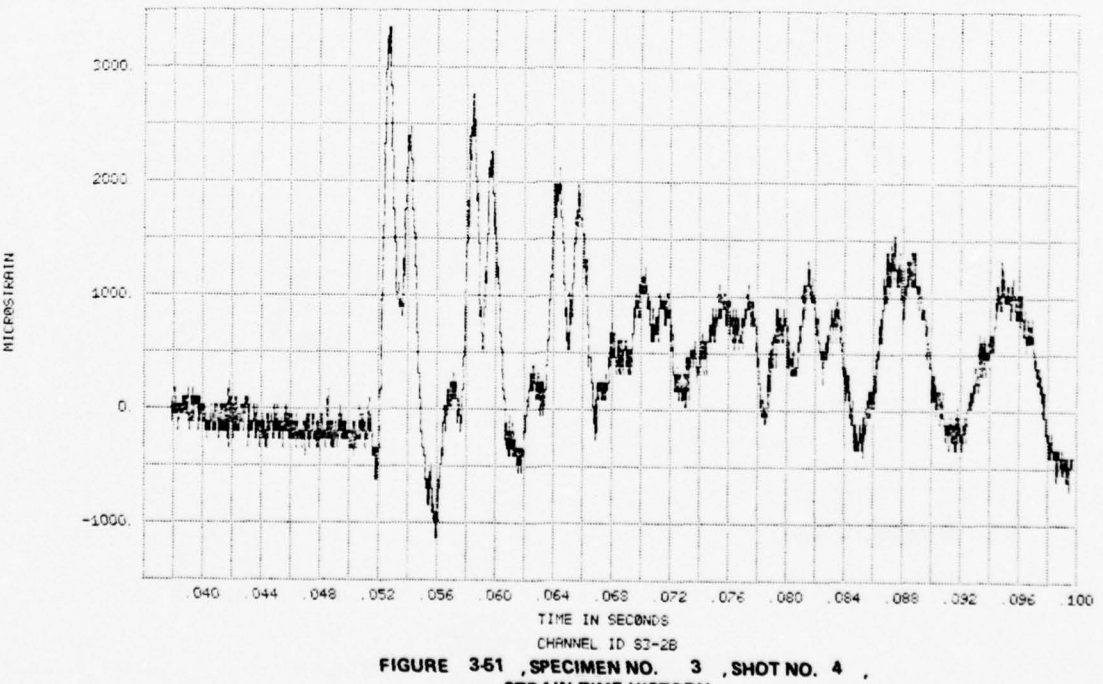


FIGURE 3-51 , SPECIMEN NO. 3 , SHOT NO. 4 ,
STRAIN TIME HISTORY

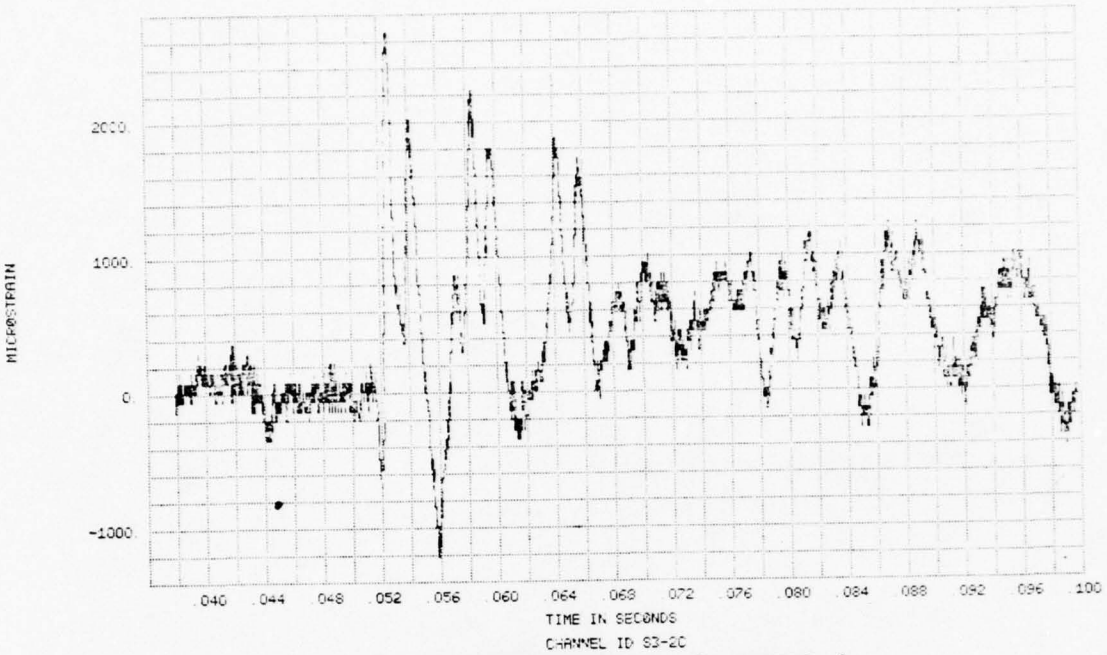


FIGURE 3-52 , SPECIMEN NO. 3 , SHOT NO. 4 , STRAIN TIME HISTORY

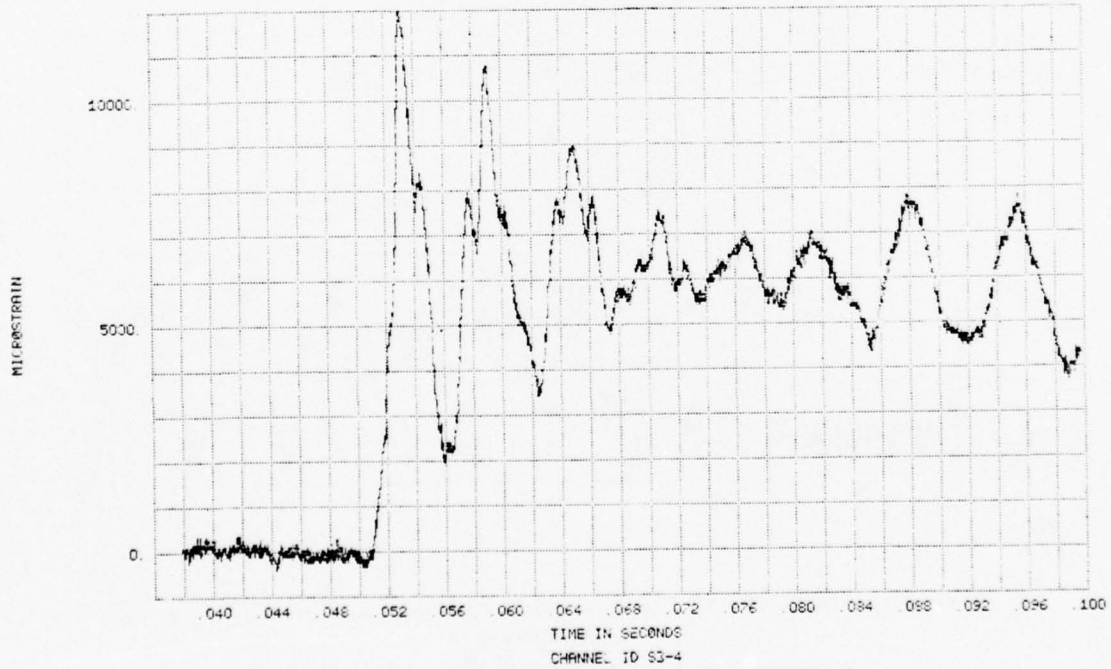
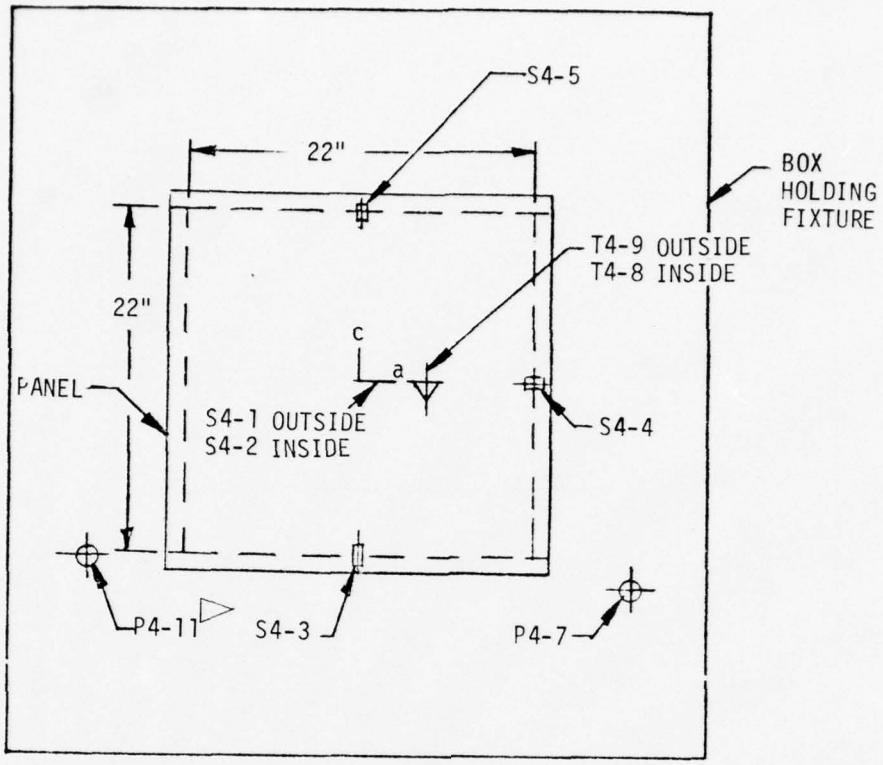


FIGURE 3-53 , SPECIMEN NO. 3 , SHOT NO. 4 , STRAIN TIME HISTORY



SPECIMEN NO. 4

FLAT UNSTIFFENED PANEL

FOUR SIDES CLAMPED

MATERIAL - 6061-T42 ALUMINUM ALLOY

DENSITY - .0002539 lb-sec^2/in^4 (MIL-HDBK-5)

POISSON'S RATION - .33

MODULUS OF ELASTICITY - 10.6 x 10^6 PSI

SHEAR MODULUS - 3.8 x 10^6 PSI

% ELONGATION - 26.8

F_{ty} = 19,380 PSI

F_{tu} = 37,810 PSI

THICKNESS - .315 IN.

▷ ON BACK SIDE OF BOX HOLDING FIXTURE ONLY

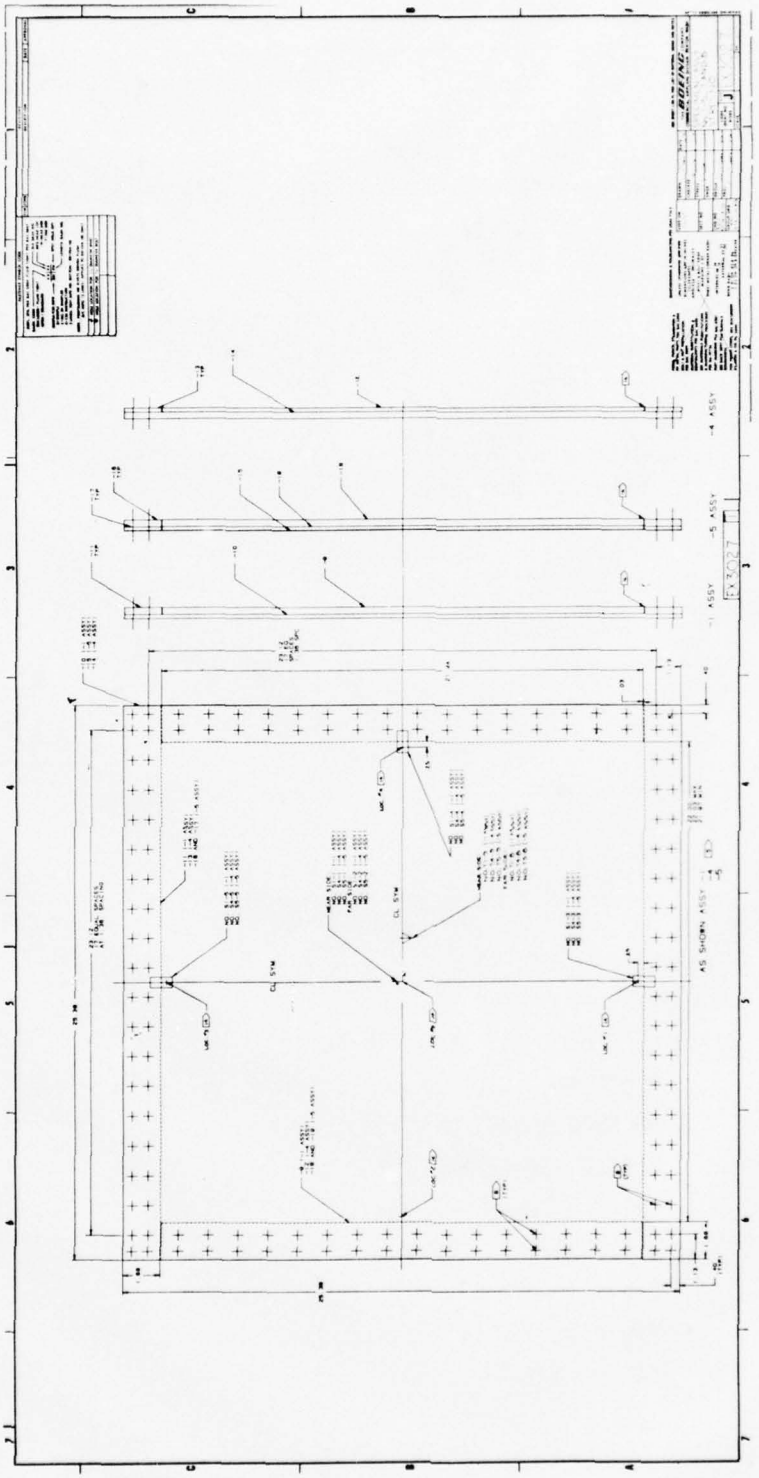




FIGURE 4-1 - SPECIMEN NO. 4 - INSTRUMENTATION - FRONT

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.4 - STATIC ANALYSIS - PRESS = 5.0 PSI - MAY'70 - STRING
          1              0
0.0        0.1            0.01          0.0
0.0        0.0            0.0           0.0
          15             15
100000.

          2              0
          2
          0              0
          0              0
          2              2
0.0        0.0
0.0        42.0
-42.0      0.0
-42.0      42.0
          0
          4              1             1
-21.0      0.0            21.0
-5.0
          5              5             11            11
          0              1             1
         10
          2              3
          3              4
          3              5
          4              3
          4              4
          4              5
          5              2
          5              3
          5              4
          5              5
          1
22.0       22.0
0.315      .0002539
10600000.  10600000.      0.33          0.33          3800000.
19380.     19380.
0.0        0.0            0.0           0.0           0.0           0.0
0.0        0.0            0.0           0.0           0.0           0.0
0.0        0.0            0.0           0.0           0.0           0.0
0.0        0.0            0.0           0.0           0.0           0.0
0.0
.000001    .000001        1.0
```

TABLE XXVII

STATIC TEST STRESSES - SPECIMEN NO. 4
(STRESSES GIVEN IN PSI)

STRAIN GAUGE	STATIC PRESSURE (PSI)								
	1.8	3.6	5.4	6.3	7.2	7.65	8.1	8.55	9.0
S4-1	-1327.	-2765.	-4079.	-4721.	-5334.	-5658.	-5966.	-6290.	-6591.
S4-2	1448.	2797.	4249.	4961.	5694.	6057.	6382.	6558.	7154.
S4-3	2486.	4937.	7435.	8731.	9992.	10610.	11301.	11895.	12537.
S4-4	2201.	4365.	6495.	7673.	8755.	9278.	9801.	10290.	10837.
S4-5	2356.	4711.	7209.	8482.	9731.	10396.	11063.	11645.	12335.

TABLE XXVIII

STATIC TEST DISPLACEMENTS - SPECIMEN NO. 4
(DISPLACEMENT MEASURED AT CENTER OF PANEL)

	STATIC PRESSURE (PSI)								
	1.8	3.6	5.4	6.3	7.2	7.65	8.1	8.55	9.0
DISPLACEMENT (INCHES)	.020	.041	.062	.072	.082	.088	.093	.098	.103

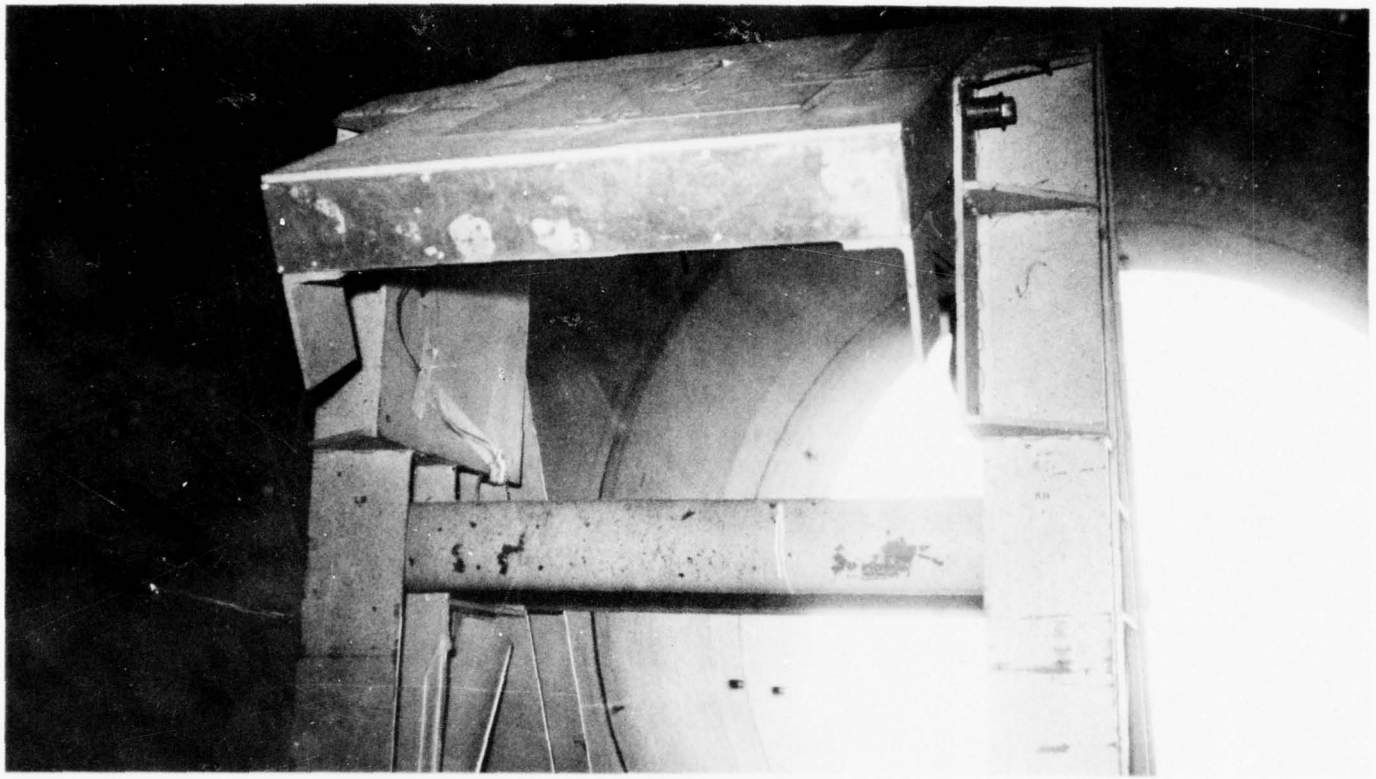


FIGURE 4-2 - SPECIMEN NO. 4 - SHOCK TEST SET-UP AT 30 DEGREES ANGLE OF ATTACK

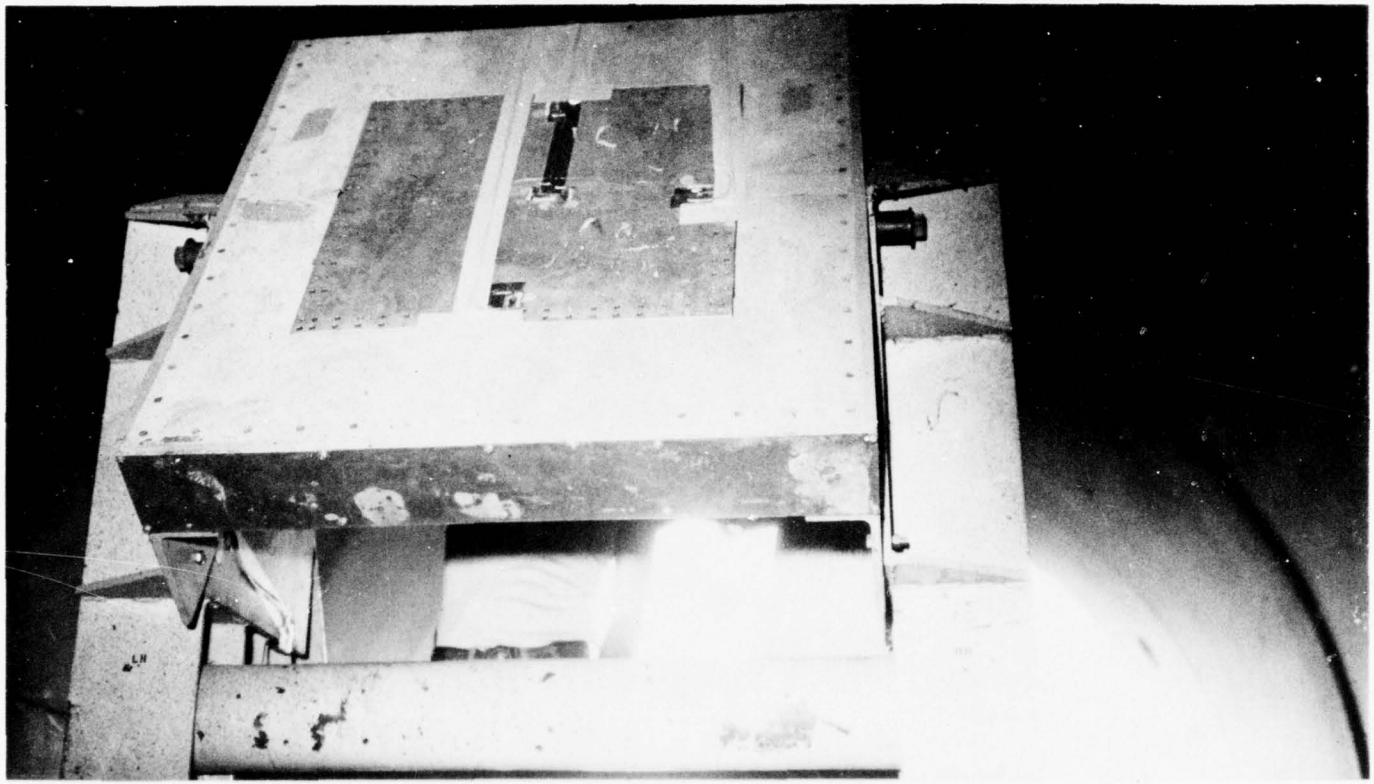


FIGURE 4-3 - SPECIMEN NO. 4 - SHOCK TEST SET-UP AT 60 DEGREES ANGLE OF ATTACK

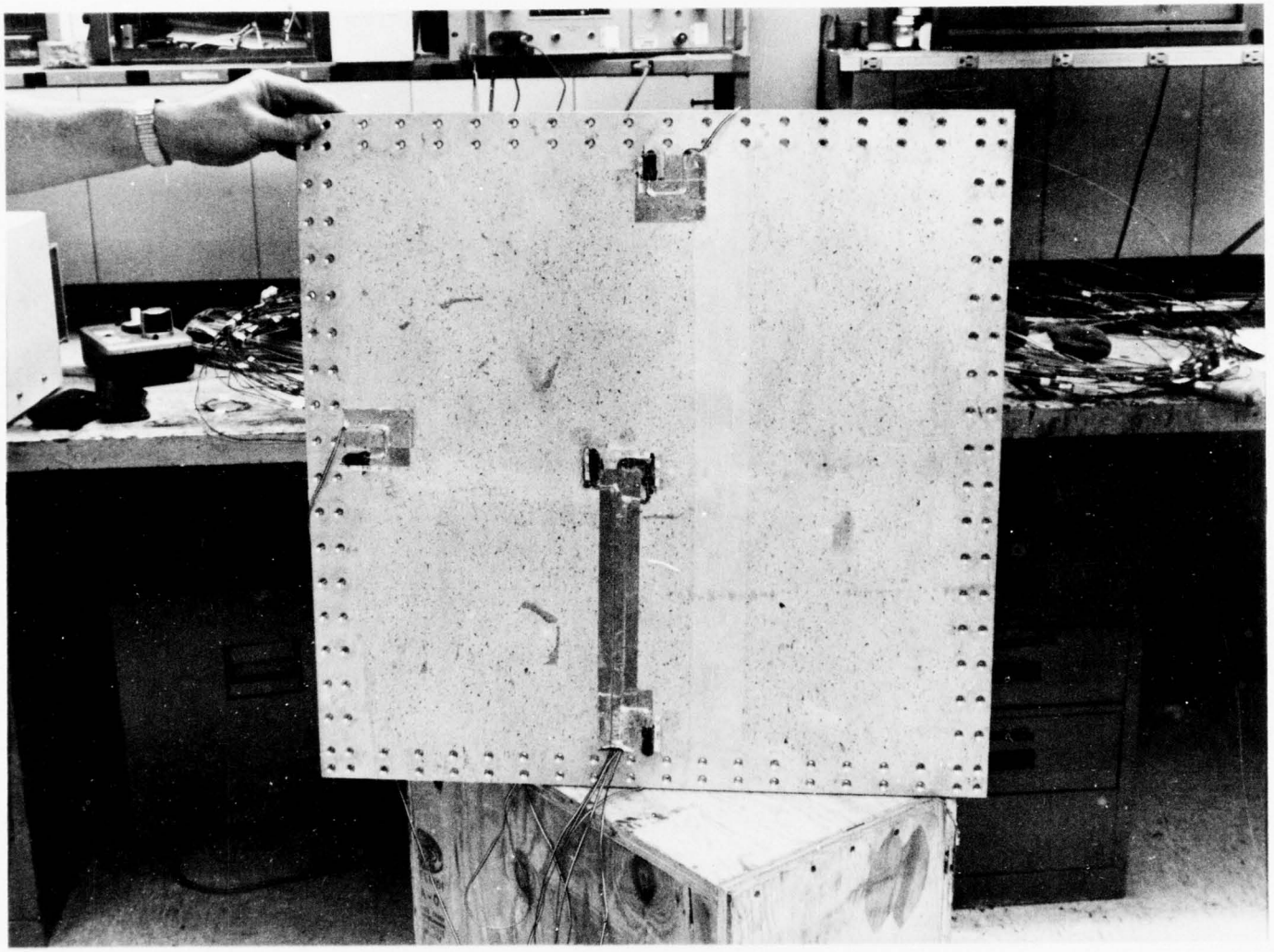


FIGURE 4-4 - SPECIMEN NO. 4 - SPECIMEN AFTER SHOCK TEST

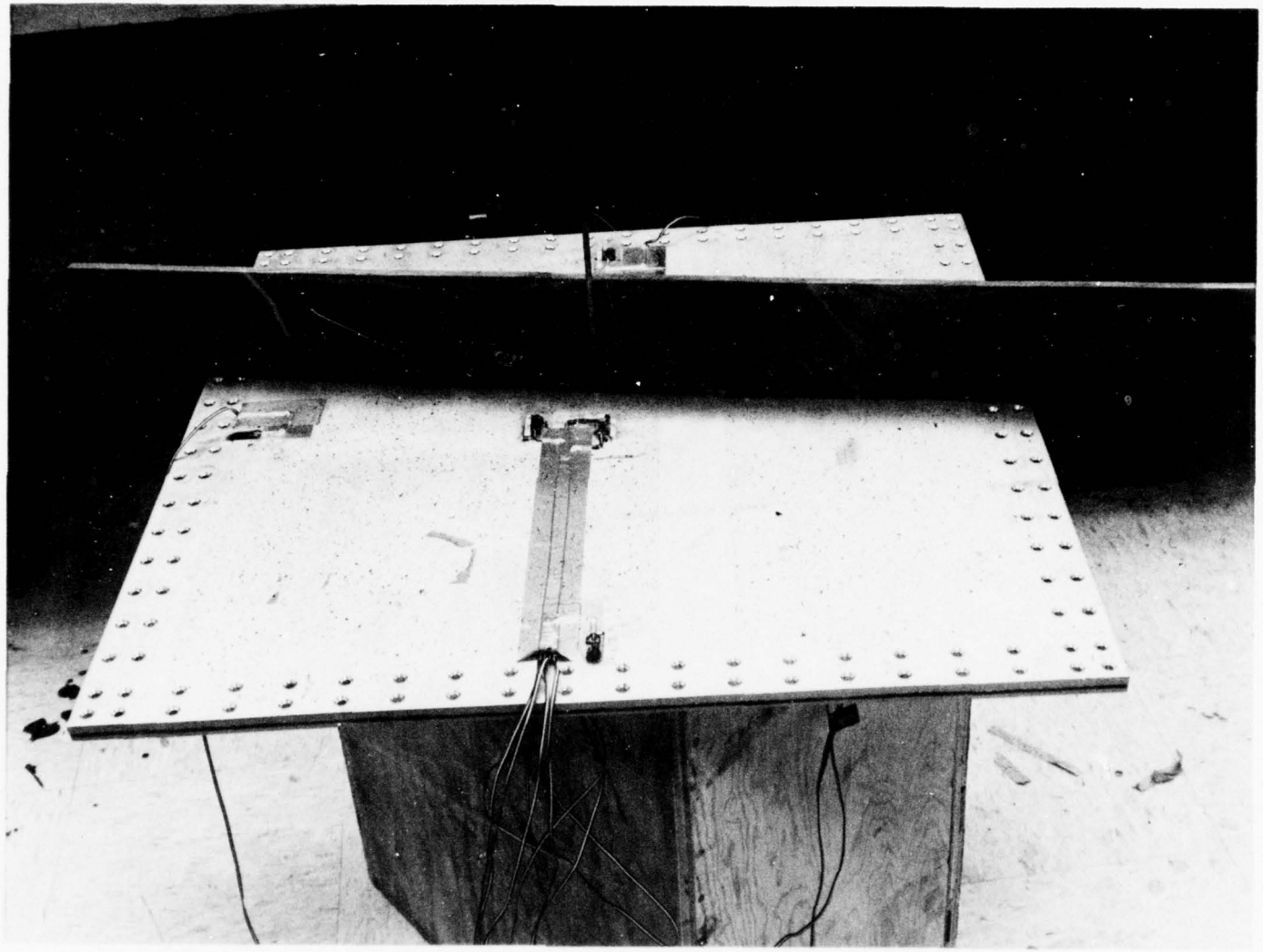


FIGURE 4-5 - SPECIMEN NO. 4 - INDICATION OF SHOCK TEST PERMANENT DEFORMATION

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.4 -DYNAMIC ANALYSIS - ITERATIVE TPD SOLUTION                    GP  1
          1              0                                                       GP  2
5000.      0.001          0.02          0.0                                     GP  3
0.0        0.0            0.0           0.0                                     GP  4
         15             15                                                      GP  5
400.                                                                            GP  7
                                                                                GP  8
          2              0                                                       GP  9
          0              1                                                       GP 10
0.5                                                                             GP 11
          0              0                                                       GP 12
          0              0                                                       GP 13
          2              2                                                       GP 14
48.0       0.0                                                                  GP 17
20.0      96.0                                                                  GP 18
-60.0      0.0                                                                  GP 19
-70.0     96.0                                                                  GP 20
          0                                                                     GP 21
          4              1              1                                       GP 25
-21.0      0.0           21.0                                                  GP 26
                                                                                GP 30
          5              5             11             11             5         GPP  1
          0              1              1                                      GPP  2
         10                                                                     GPP  3
          2              5                                                      GPP  4
          3              4                                                      GPP  4
          3              5                                                      GPP  4
          4              3                                                      GPP  4
          4              4                                                      GPP  4
          4              5                                                      GPP  4
          5              2                                                      GPP  4
          5              3                                                      GPP  4
          5              4                                                      GPP  4
          5              5                                                      GPP  4
          1                                                                     GPP  5
2250       22.0                                                                 GPP  6
0.315      .0002539                                                             GPP  7
10600000. 10600000.      0.33          0.33          3800000.                  GPP  8
19380.    19380.                                                               GPP  9
0.0       0.0            0.0           0.0           0.0           0.0         GPP 13
0.0       0.0            0.0           0.0           0.0           0.0         GPP 13
0.0       0.0            0.0           0.0           0.0           0.0         GPP 13
0.0       0.0            0.0           0.0           0.0           0.0         GPP 13
0.0                                                                             GPP 13
0.0       0.010         25.0                                                   GPP 14
                                                                                GP 32
```

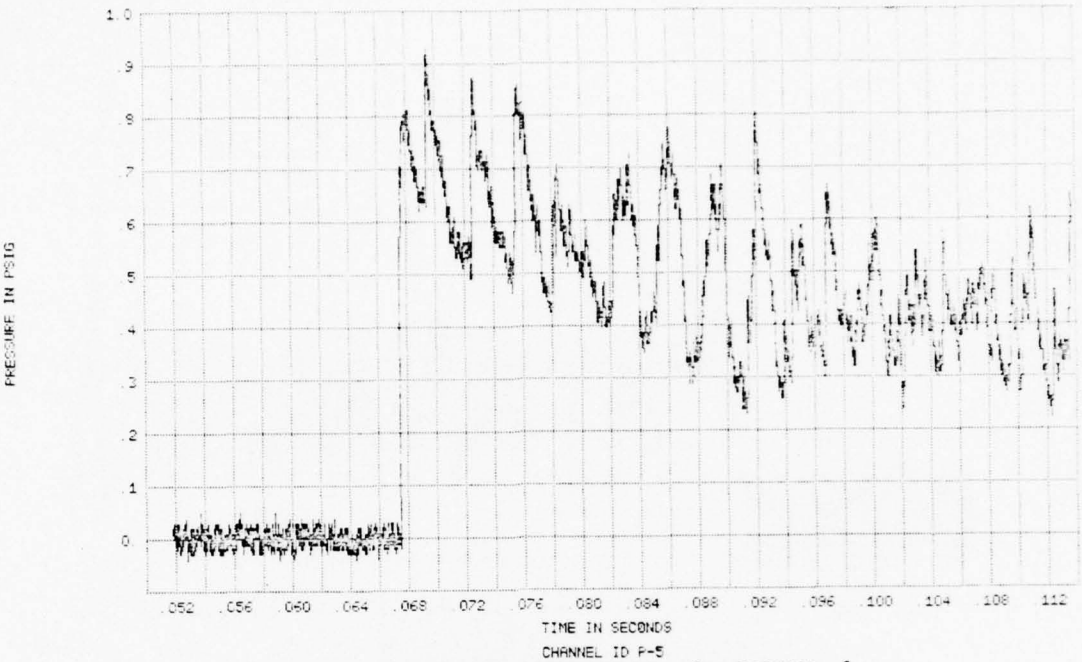


FIGURE 4-6 , SPECIMEN NO. 4 , SHOT NO. 1 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

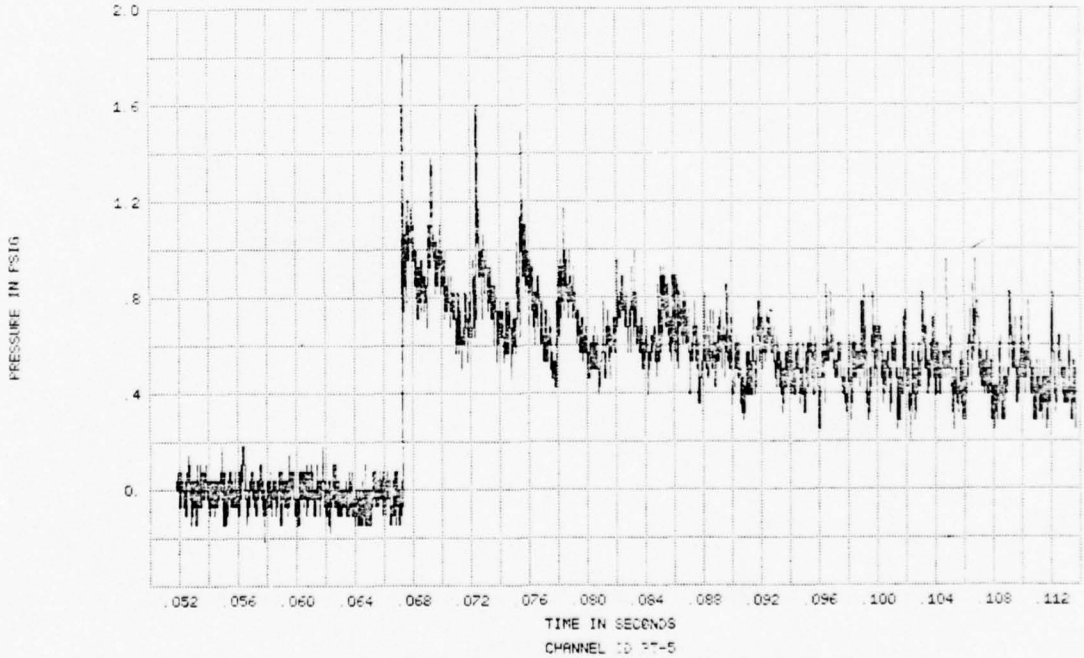


FIGURE 4-7 , SPECIMEN NO. 4 , SHOT NO. 1 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

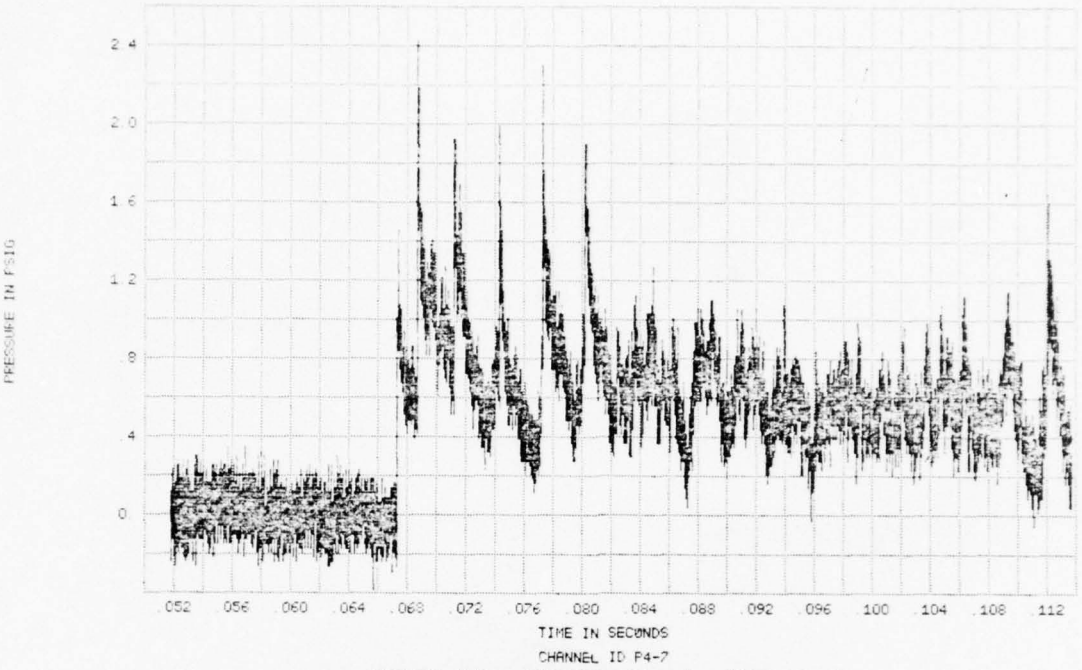


FIGURE 4-8 , SPECIMEN NO. 4 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

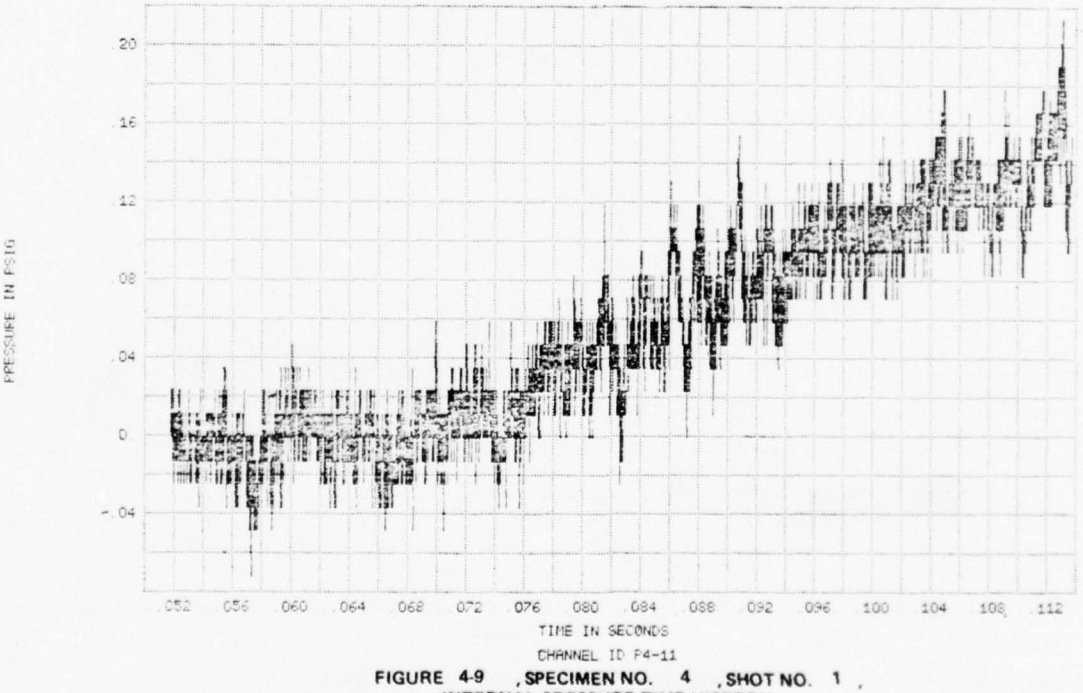


FIGURE 4-9 , SPECIMEN NO. 4 , SHOT NO. 1 ,
INTERNAL PRESSURE TIME HISTORY

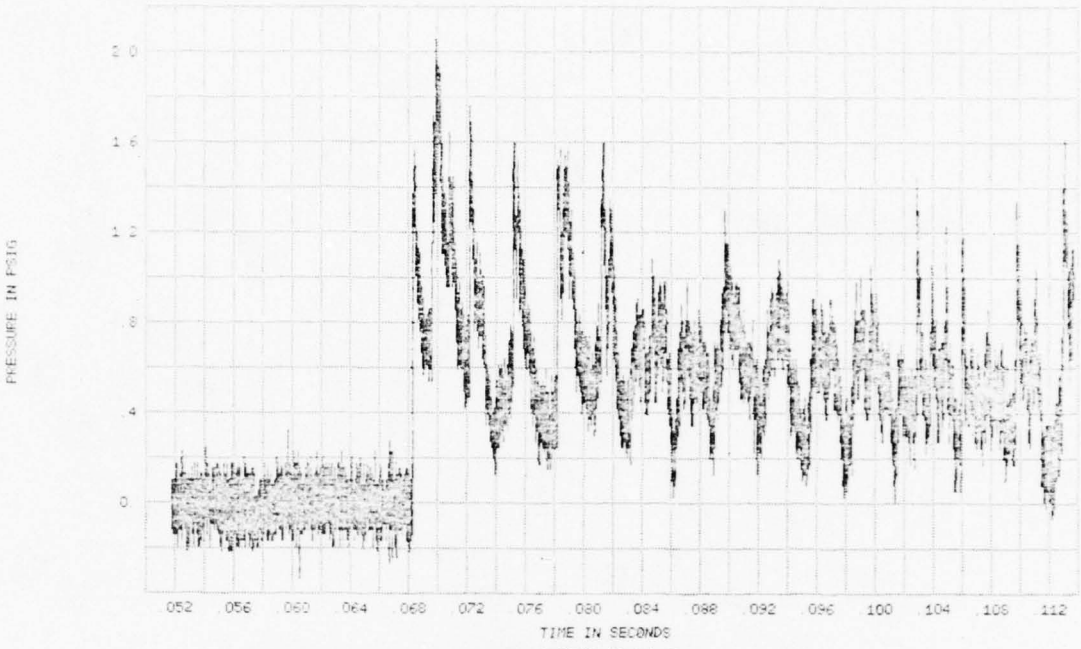


FIGURE 4-10 , SPECIMEN NO. 4 , SHOT NO. 1 , SPECIMEN REFLECTED PRESSURE TIME HISTORY

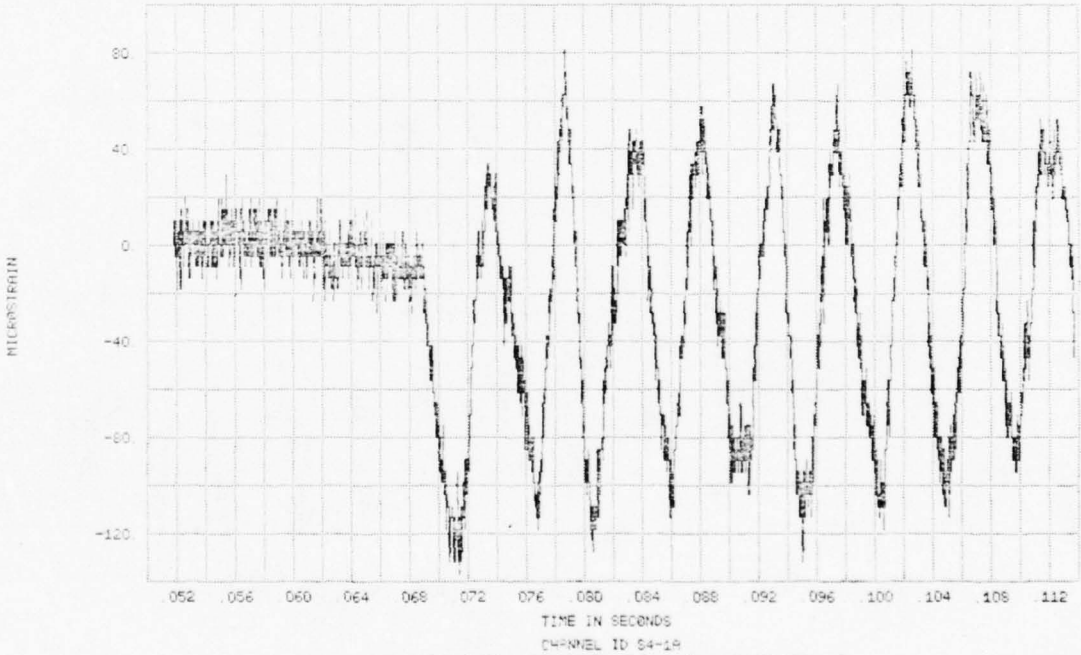


FIGURE 4-11 , SPECIMEN NO. 4 , SHOT NO. 1 , STRAIN TIME HISTORY

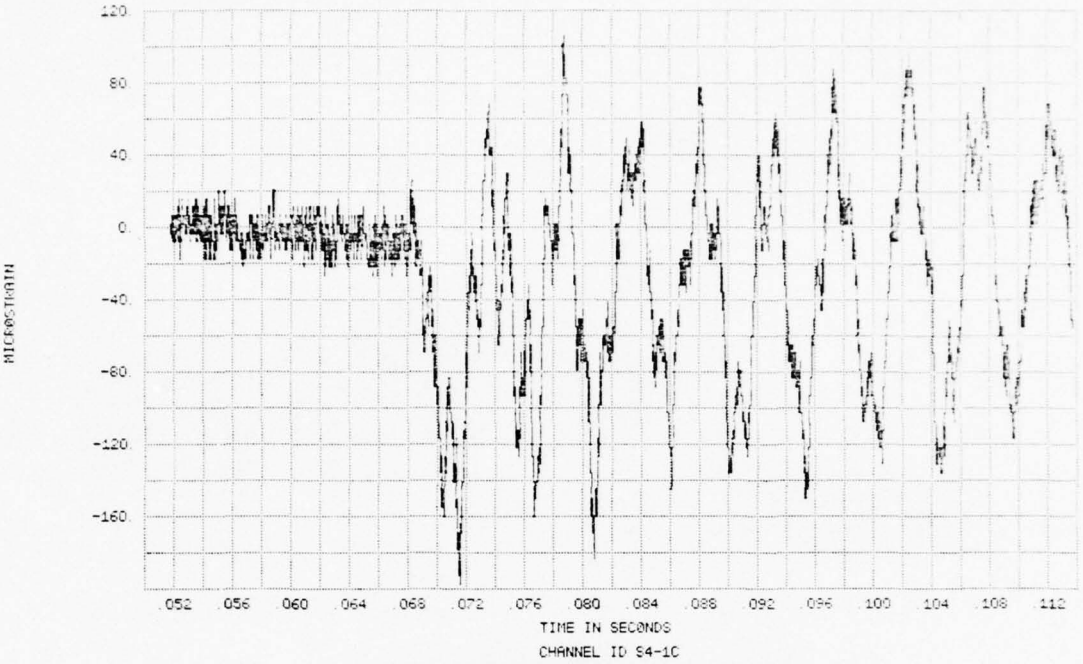


FIGURE 4-12 , SPECIMEN NO. 4 , SHOT NO. 1 , STRAIN TIME HISTORY

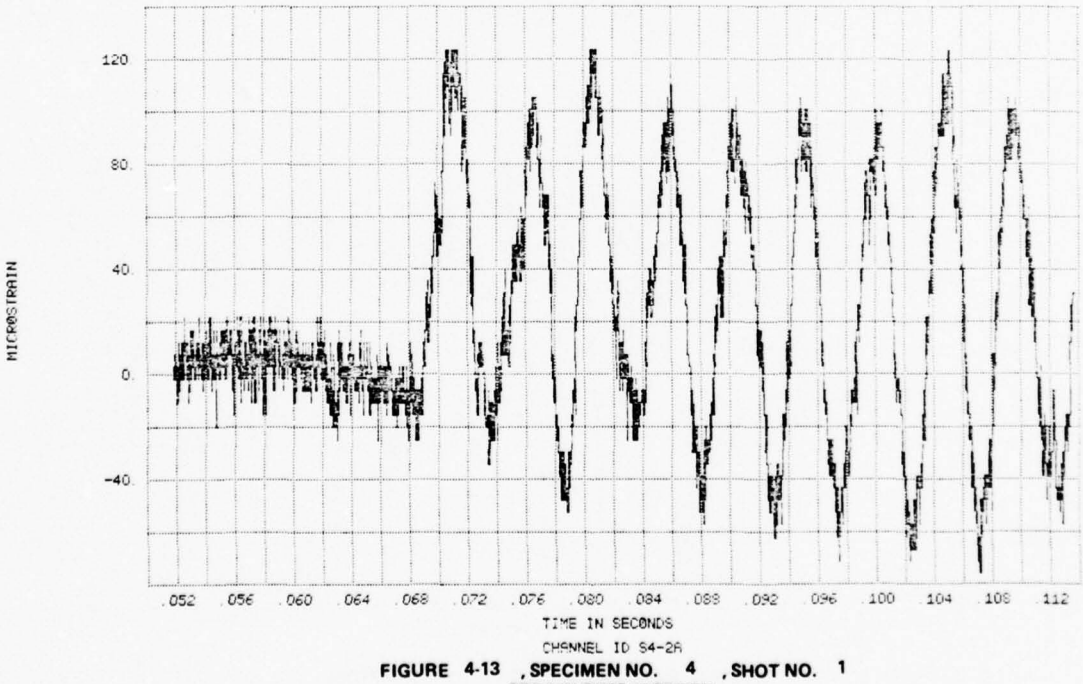


FIGURE 4-13 , SPECIMEN NO. 4 , SHOT NO. 1 STRAIN TIME HISTORY

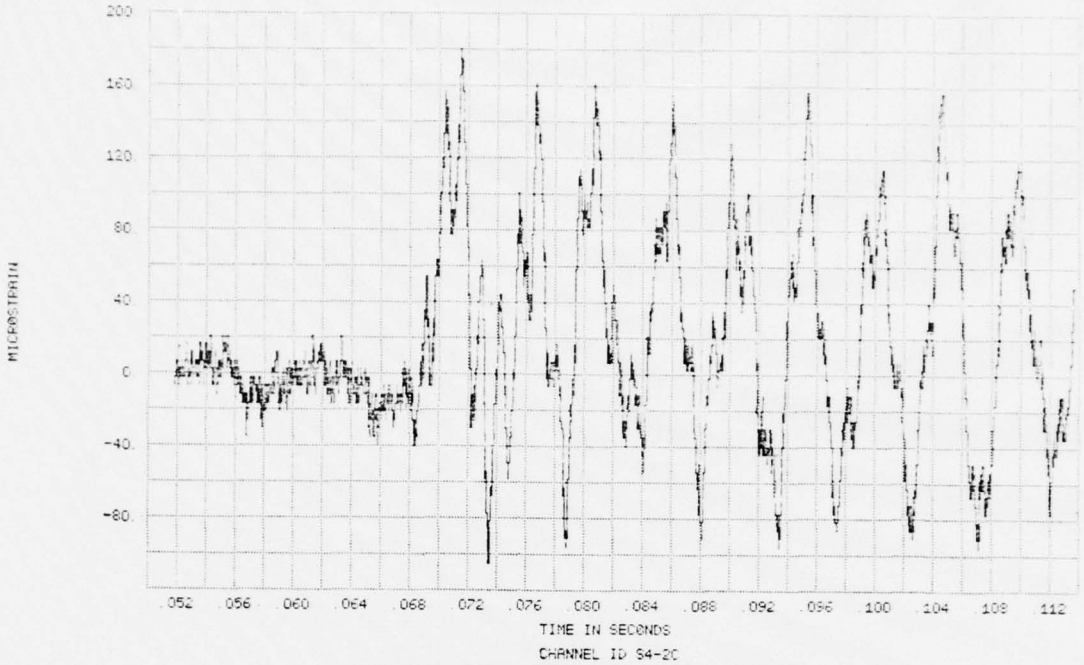


FIGURE 4-14 , SPECIMEN NO. 4 , SHOT NO. 1 ,
STRAIN TIME HISTORY

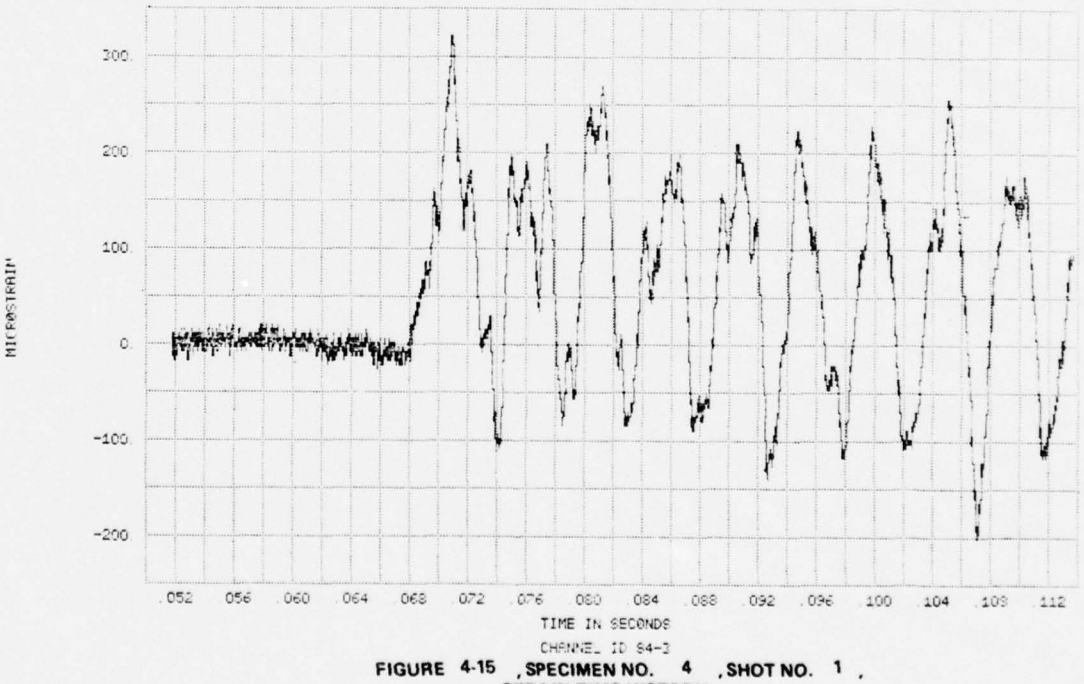


FIGURE 4-15 , SPECIMEN NO. 4 , SHOT NO. 1 ,
STRAIN TIME HISTORY

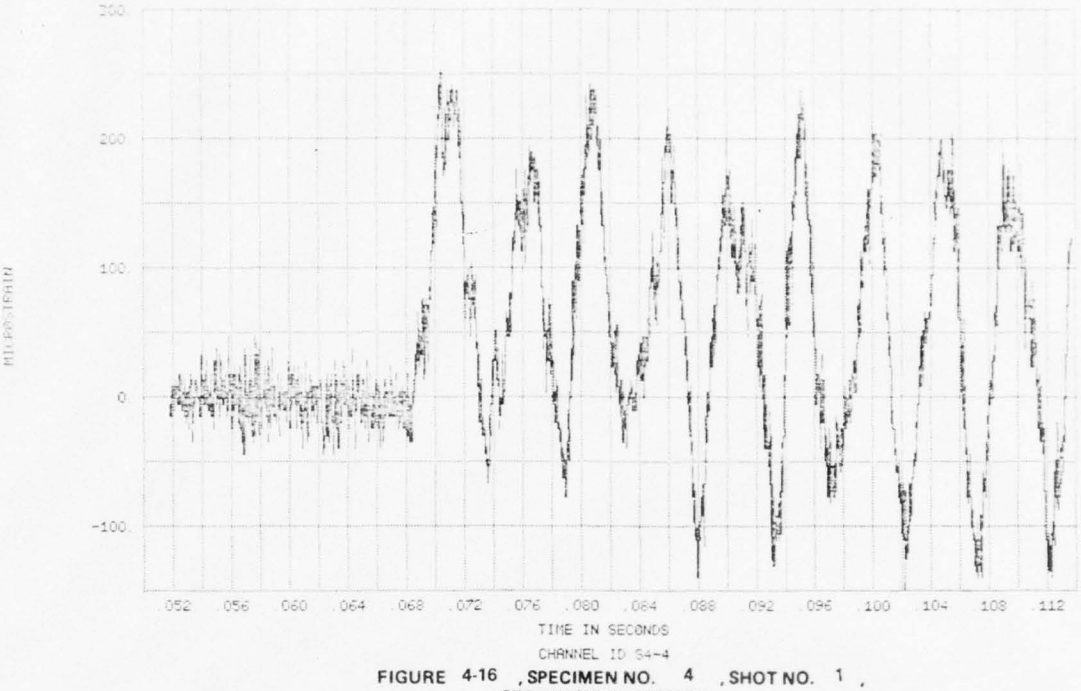


FIGURE 4-16 , SPECIMEN NO. 4 , SHOT NO. 1 ,
STRAIN TIME HISTORY

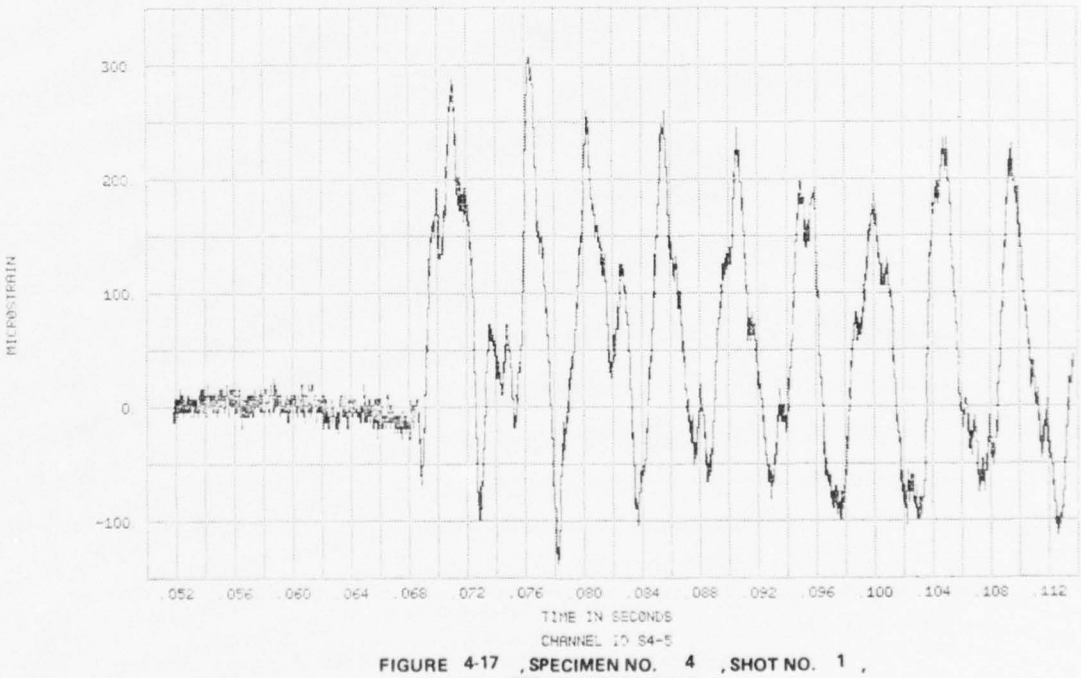


FIGURE 4-17 , SPECIMEN NO. 4 , SHOT NO. 1 ,
STRAIN TIME HISTORY

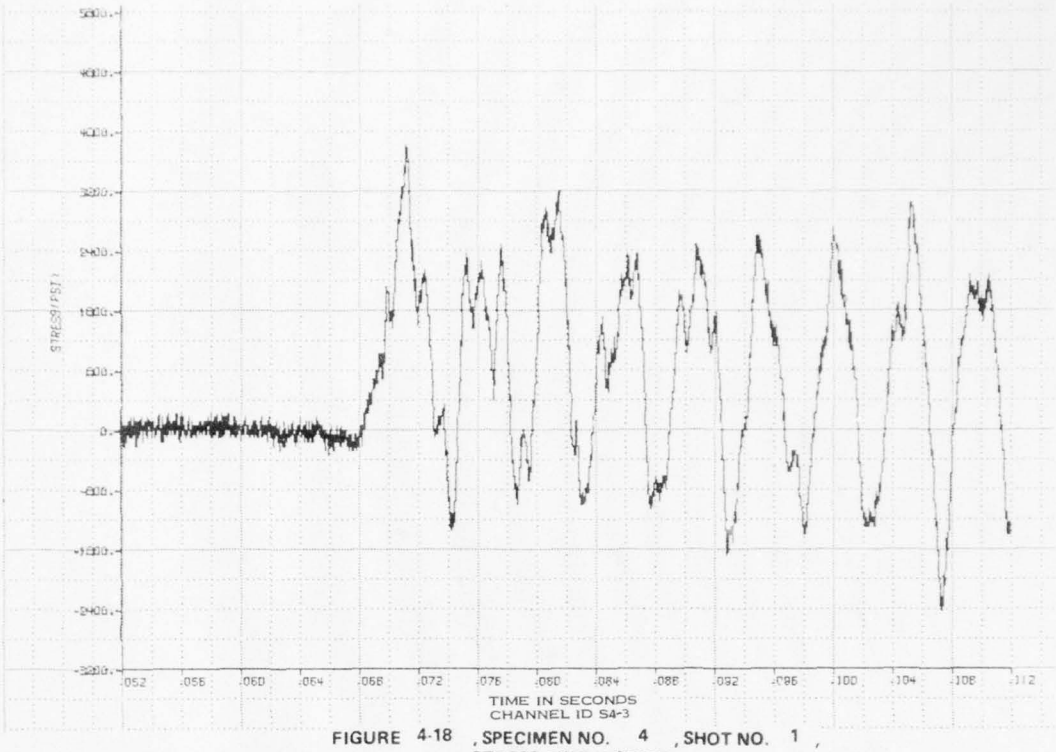


FIGURE 4-18 , SPECIMEN NO. 4 , SHOT NO. 1 ,
STRESS TIME HISTORY

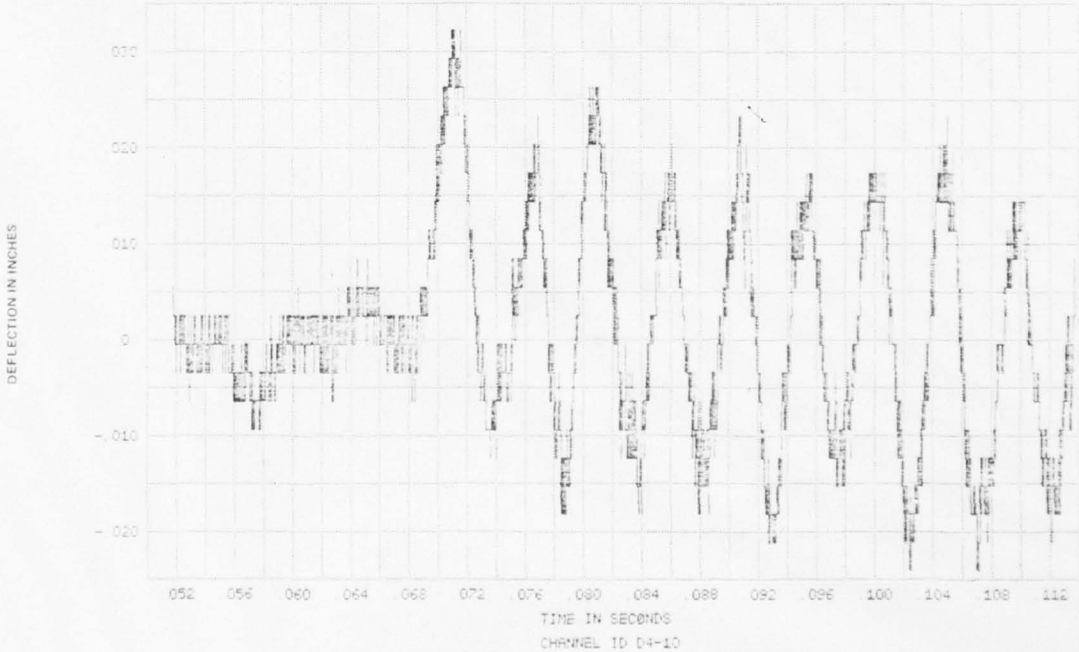


FIGURE 4-19 , SPECIMEN NO. 4 , SHOT NO. 1 ,
DEFLECTION TIME HISTORY

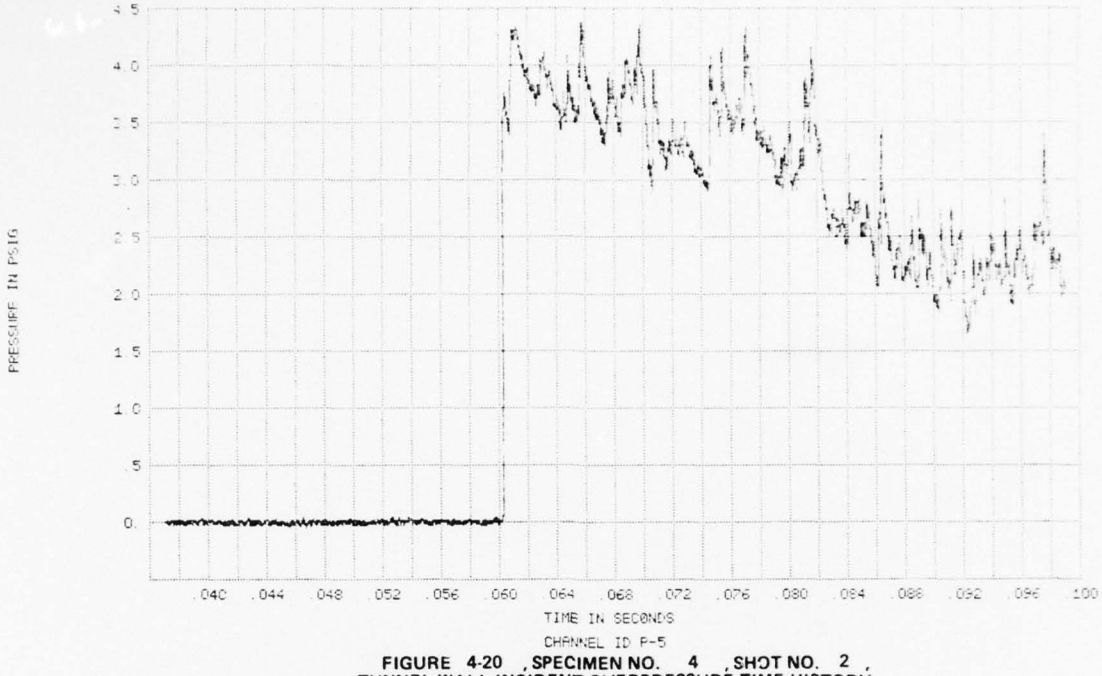


FIGURE 4-20 , SPECIMEN NO. 4 , SHOT NO. 2 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

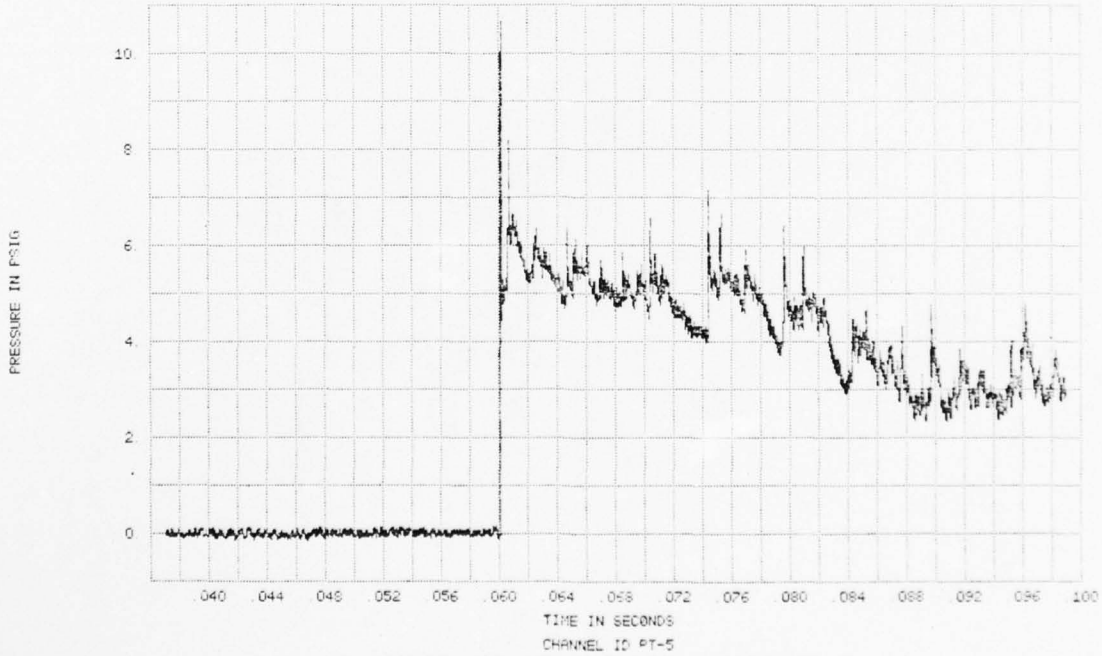


FIGURE 4-21 , SPECIMEN NO. 4 , SHOT NO. 2 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

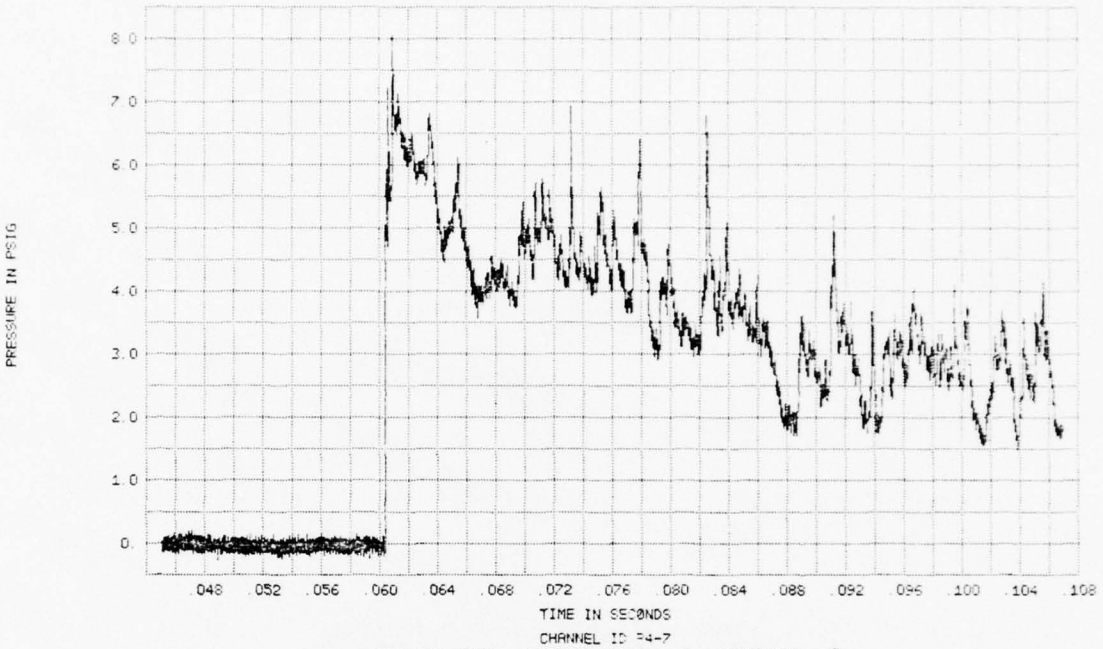


FIGURE 4-22 , SPECIMEN NO. 4 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

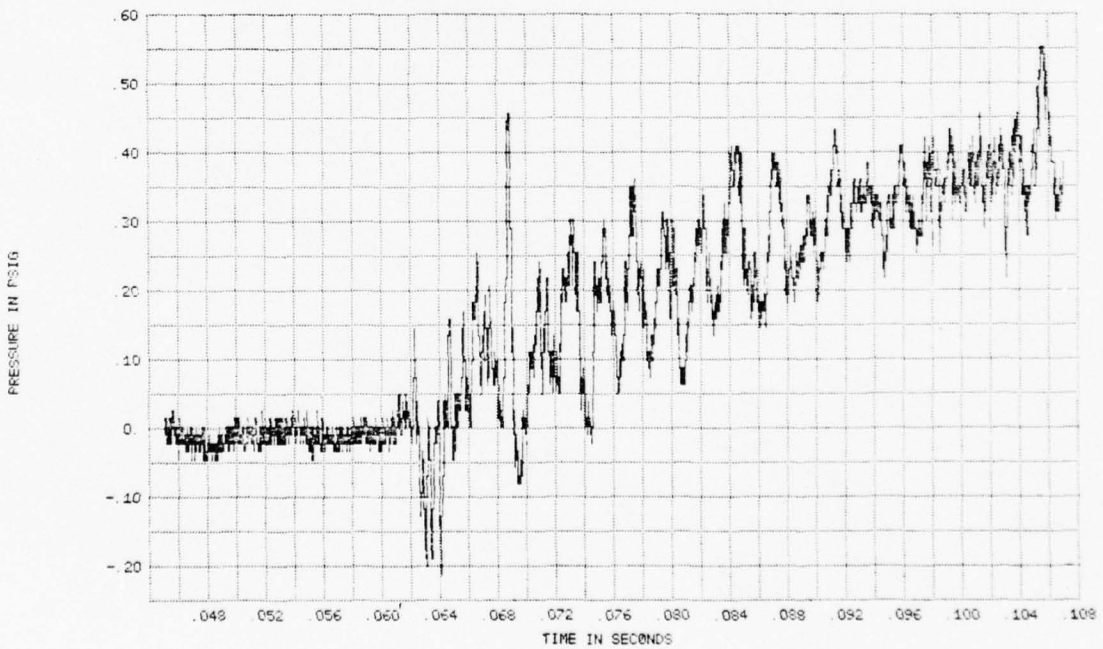


FIGURE 4-23 , SPECIMEN NO. 4 , SHOT NO. 2 ,
INTERNAL PRESSURE TIME HISTORY

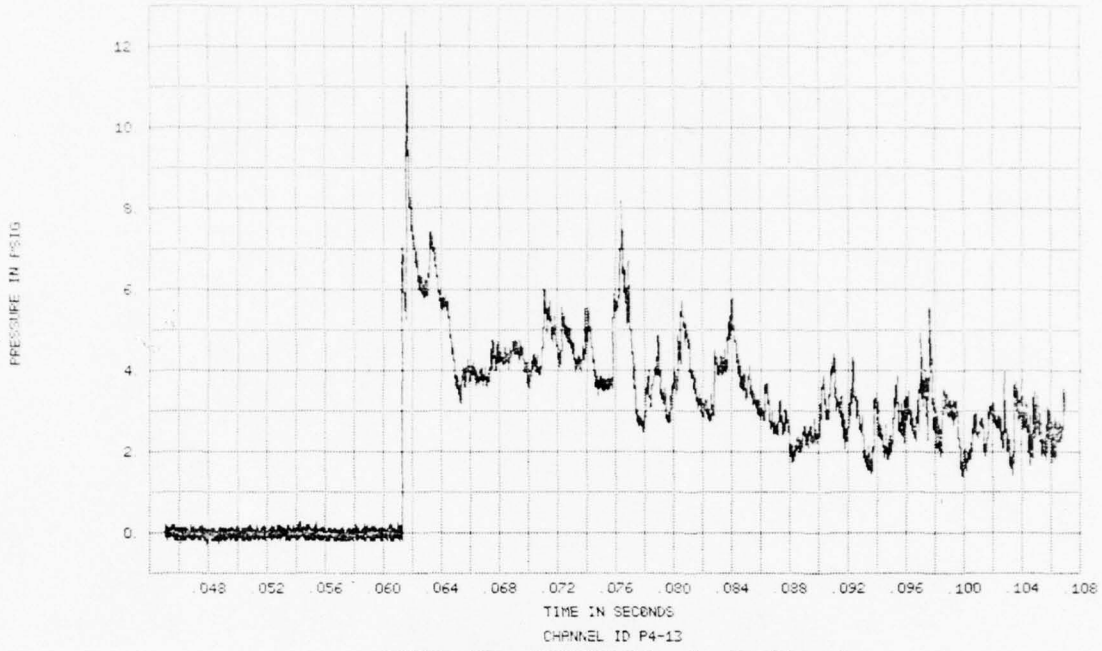


FIGURE 4-24 , SPECIMEN NO. 4 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

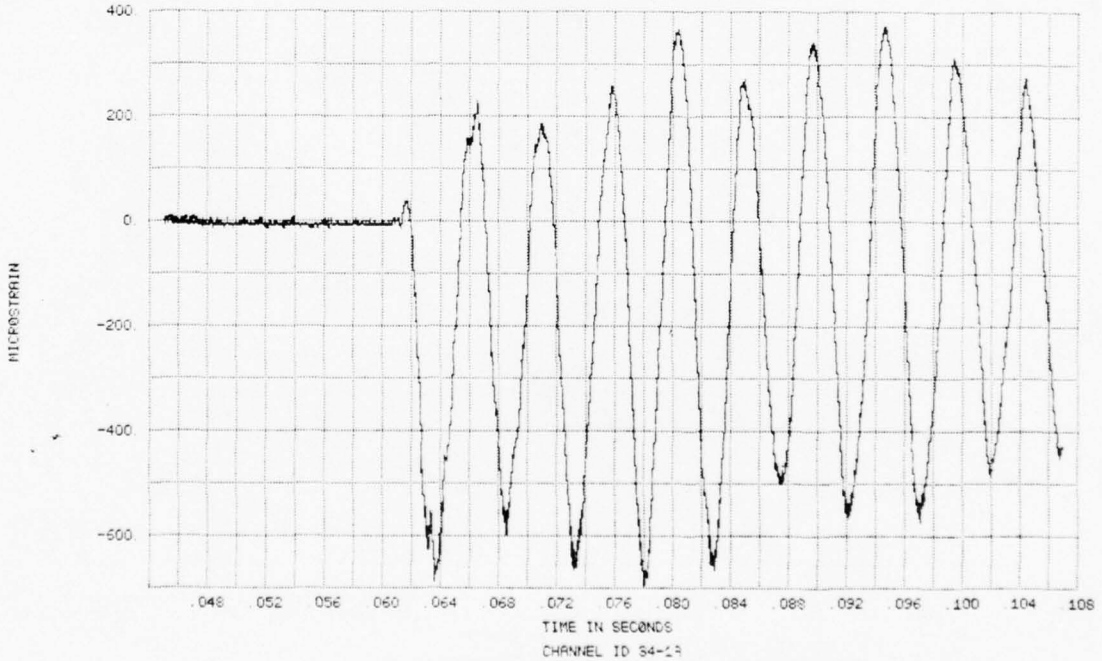


FIGURE 4-25 , SPECIMEN NO. 4 , SHOT NO. 2 ,
STRAIN TIME HISTORY

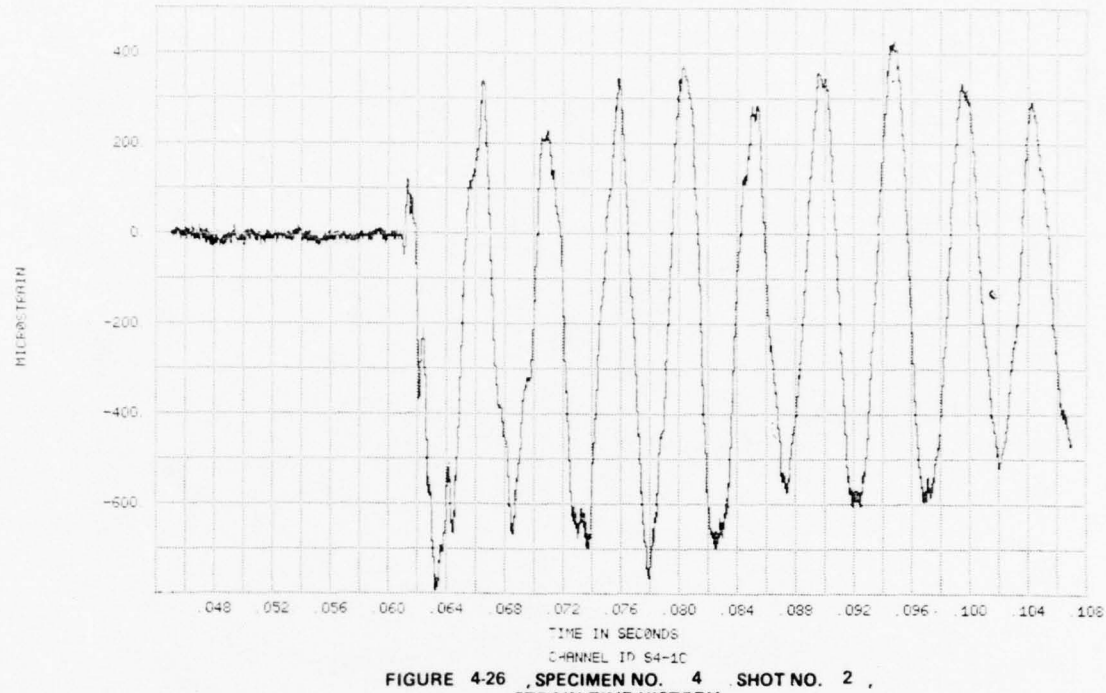


FIGURE 4-26 , SPECIMEN NO. 4 , SHOT NO. 2 , STRAIN TIME HISTORY

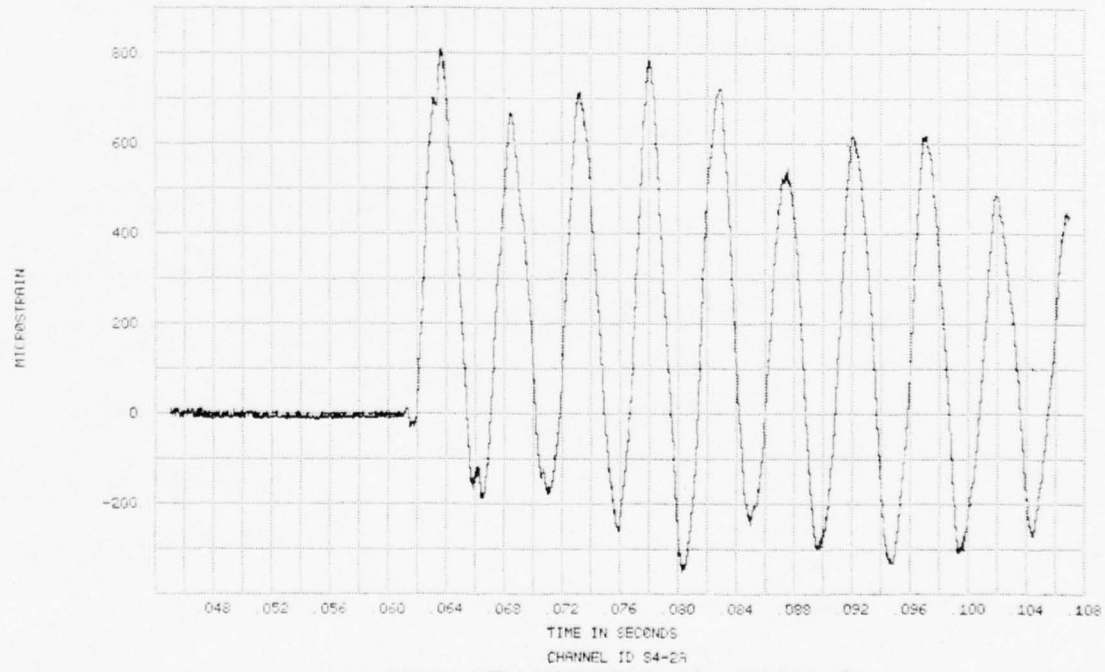


FIGURE 4-27 , SPECIMEN NO. 4 , SHOT NO. 2 , STRAIN TIME HISTORY

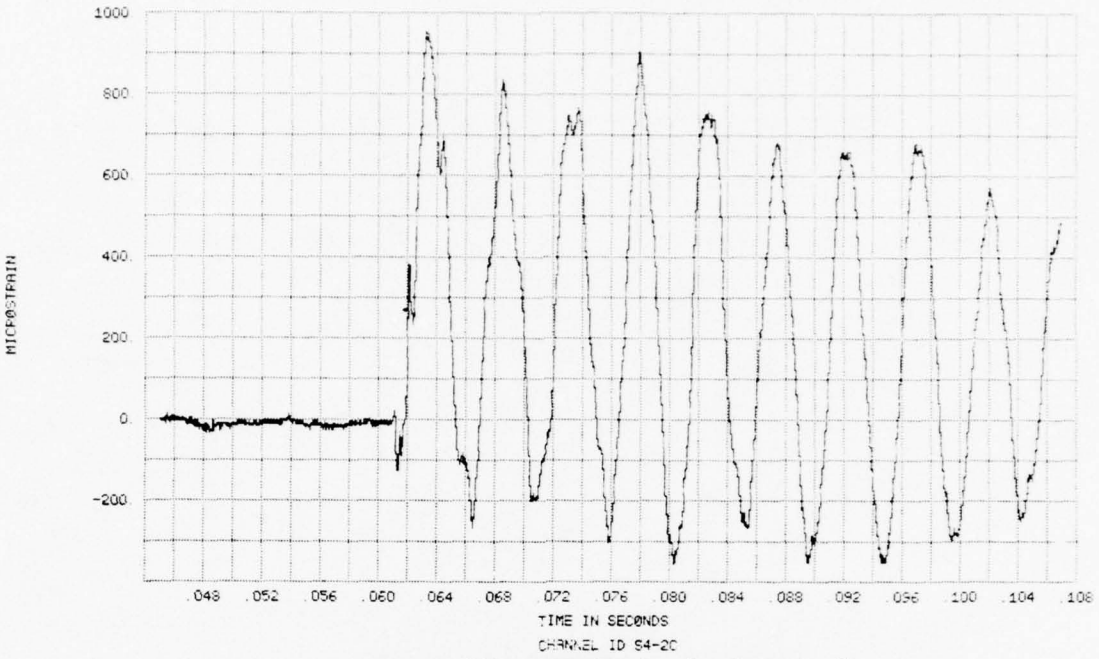


FIGURE 4-28 , SPECIMEN NO. 4 , SHOT NO. 2 , STRAIN TIME HISTORY

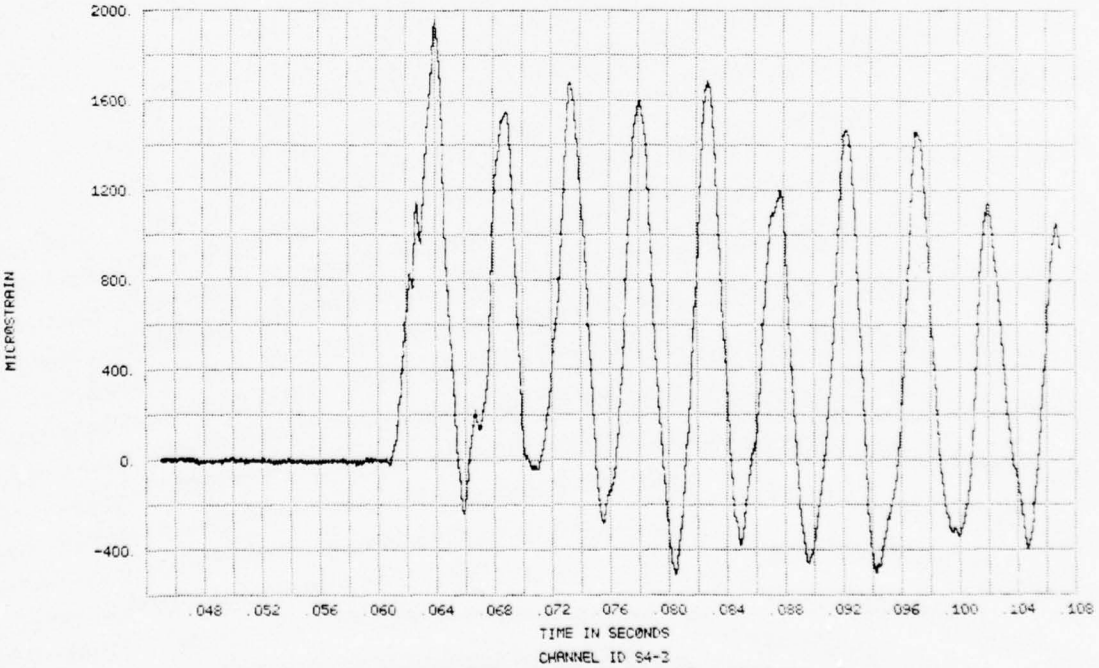


FIGURE 4-29 , SPECIMEN NO. 4 , SHOT NO. 2 , STRAIN TIME HISTORY

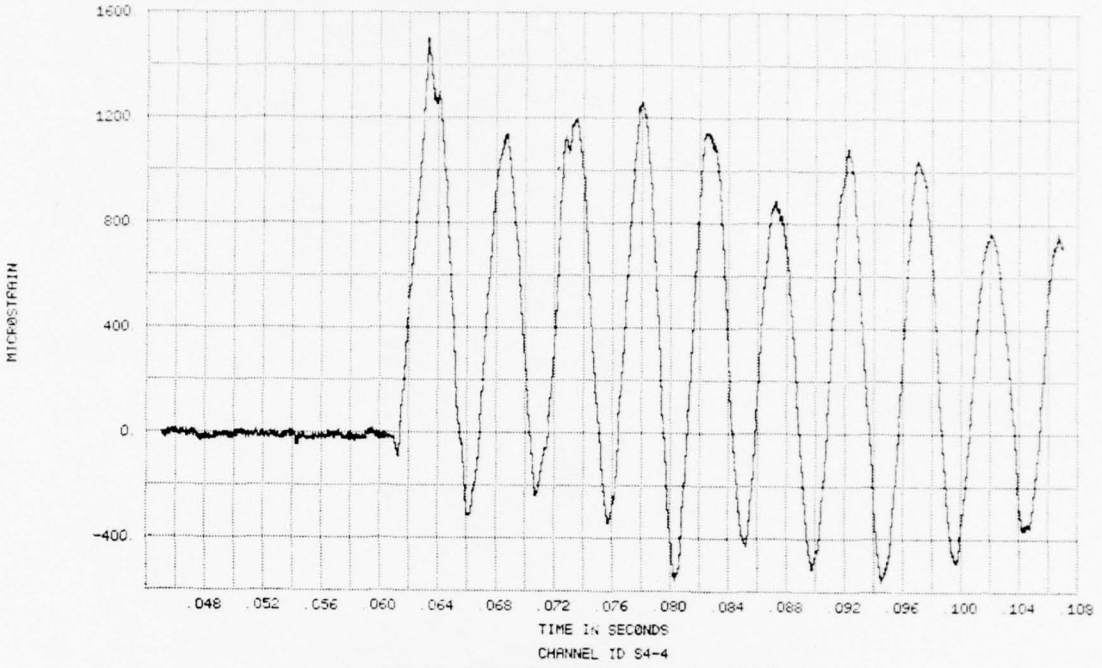


FIGURE 4-30 , SPECIMEN NO. 4 , SHOT NO. 2 , STRAIN TIME HISTORY

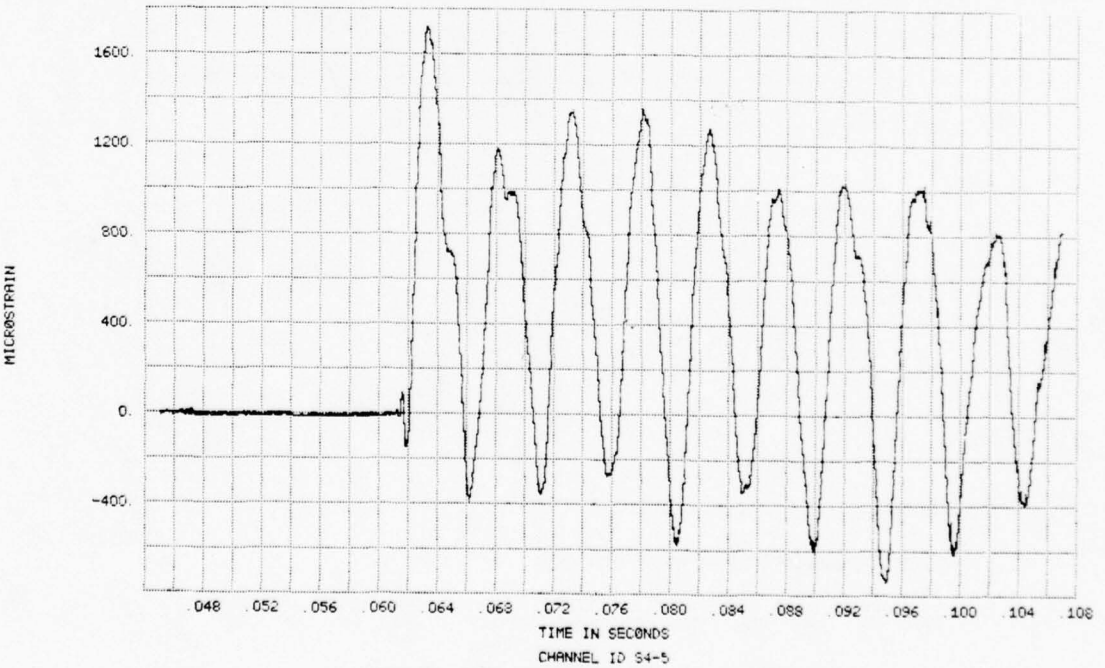


FIGURE 4-31 , SPECIMEN NO. 4 , SHOT NO. 2 , STRAIN TIME HISTORY

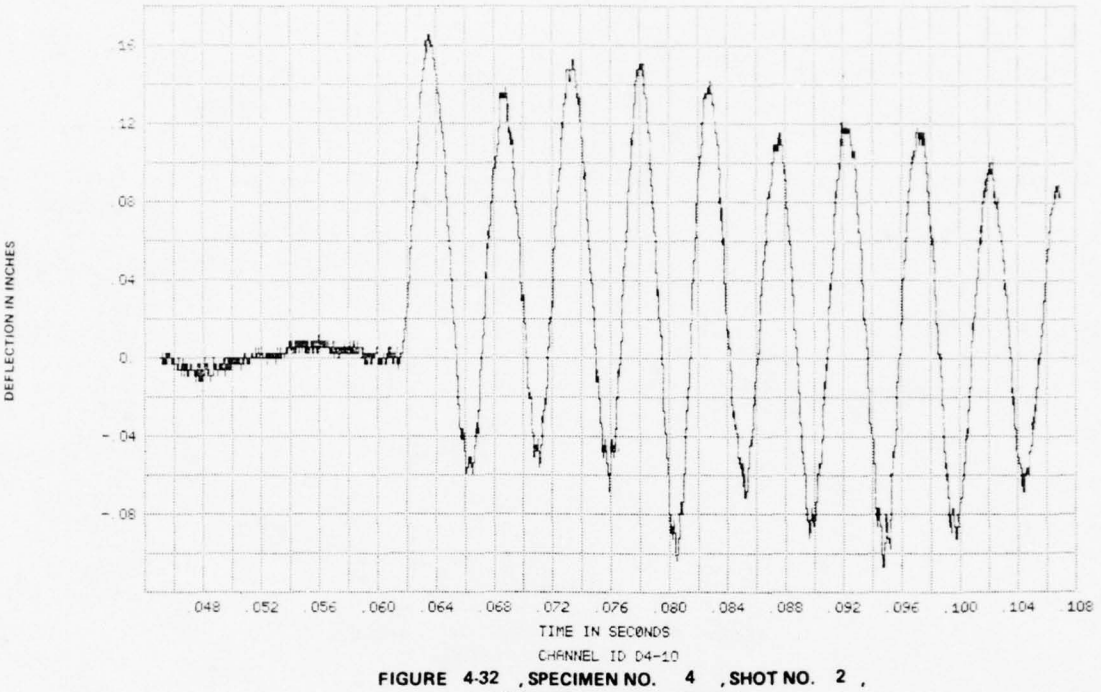


FIGURE 4-32 , SPECIMEN NO. 4 , SHOT NO. 2 ,
DEFLECTION TIME HISTORY

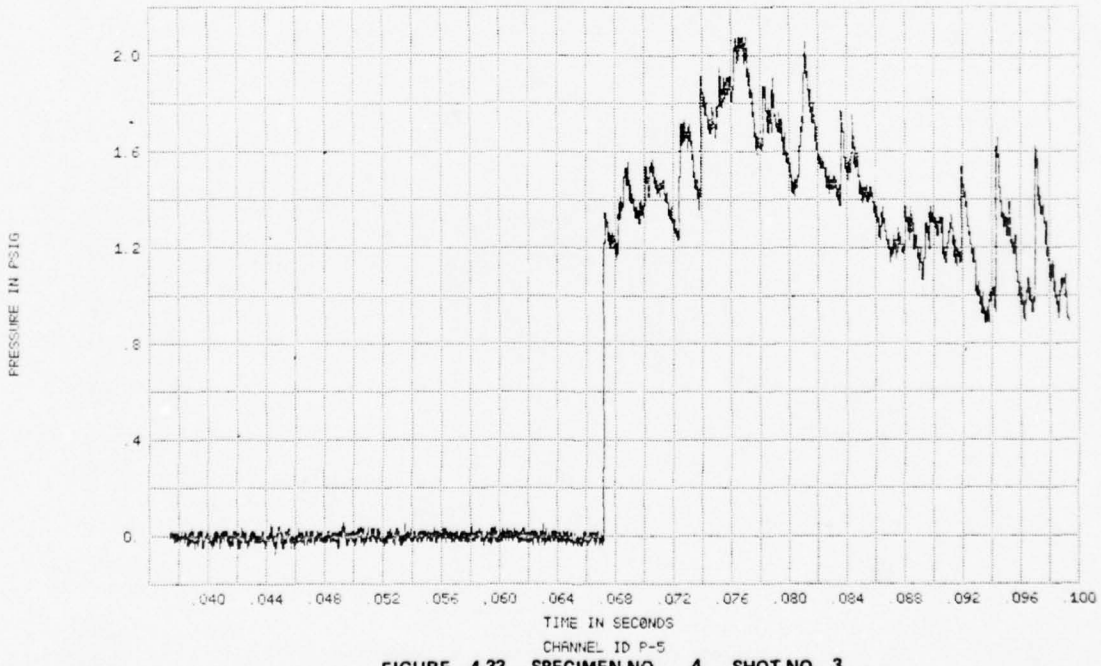


FIGURE 4-33 , SPECIMEN NO. 4 , SHOT NO. 3 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

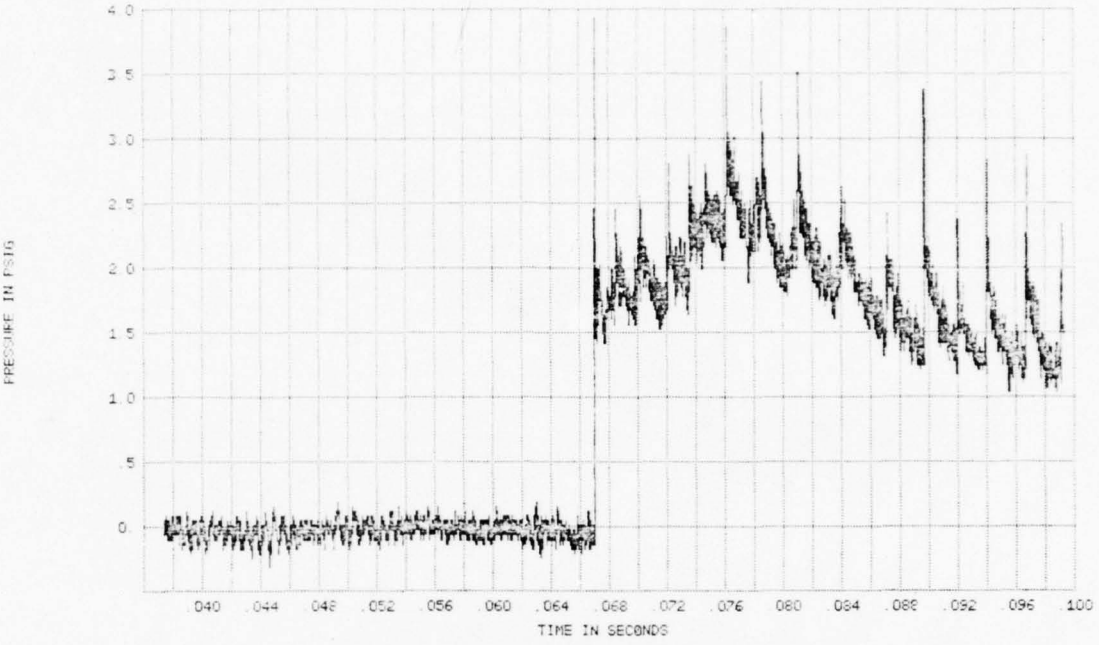


FIGURE 4-34 , SPECIMEN NO. 4 , SHOT NO. 3 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

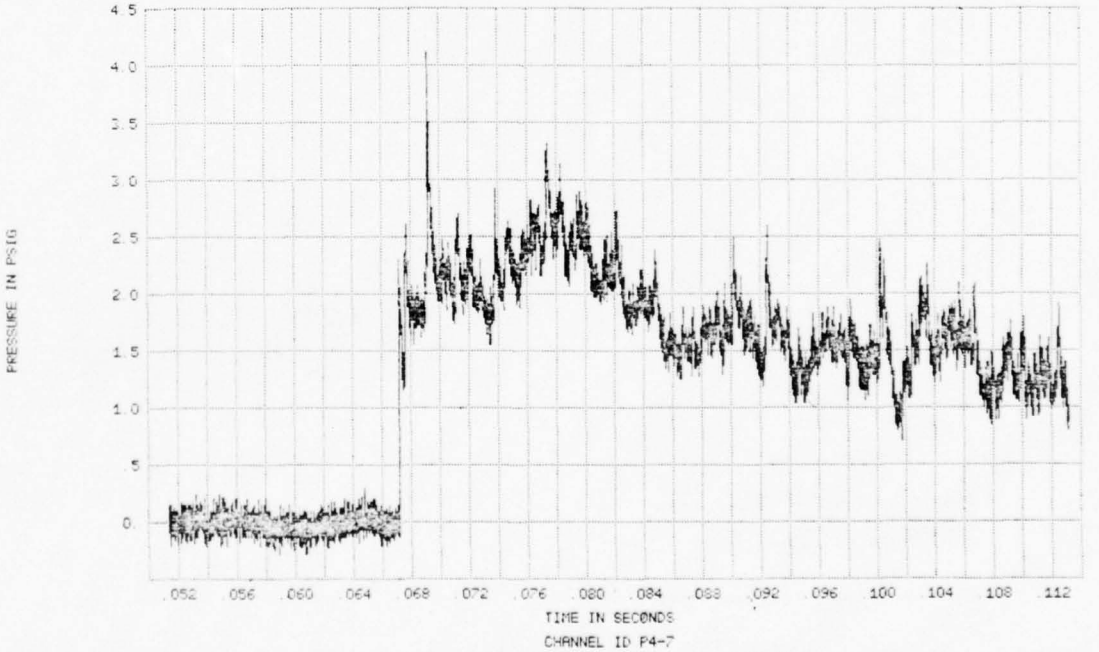


FIGURE 4-35 , SPECIMEN NO. 4 , SHOT NO. 3
SPECIMEN REFLECTED PRESSURE TIME HISTORY

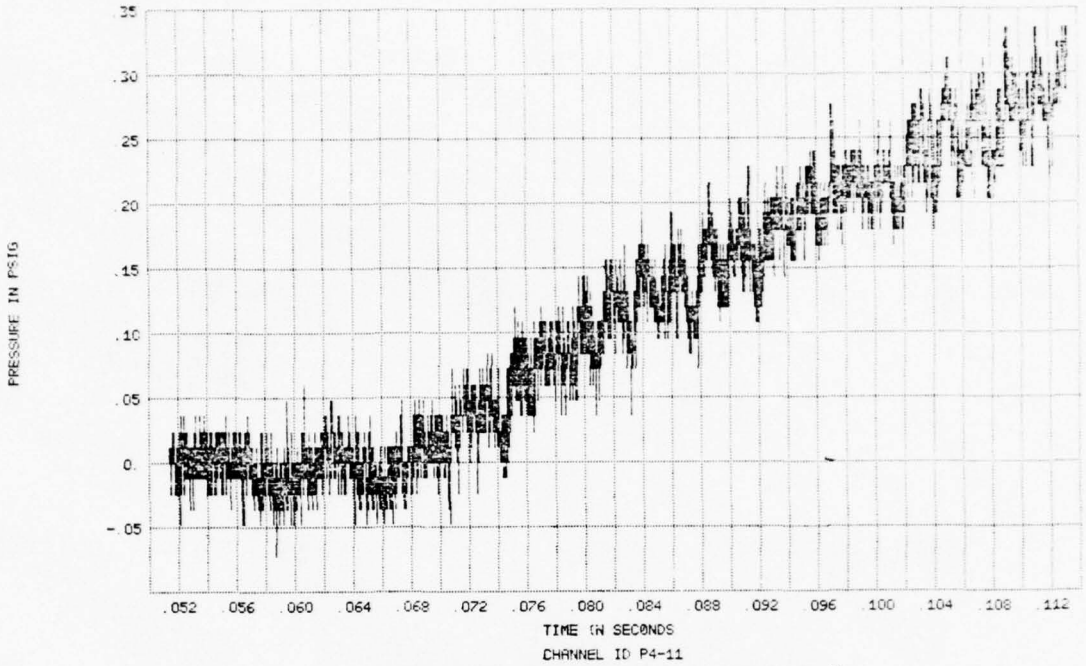


FIGURE 4-36 , SPECIMEN NO. 4 , SHOT NO. 3 ,
INTERNAL PRESSURE TIME HISTORY

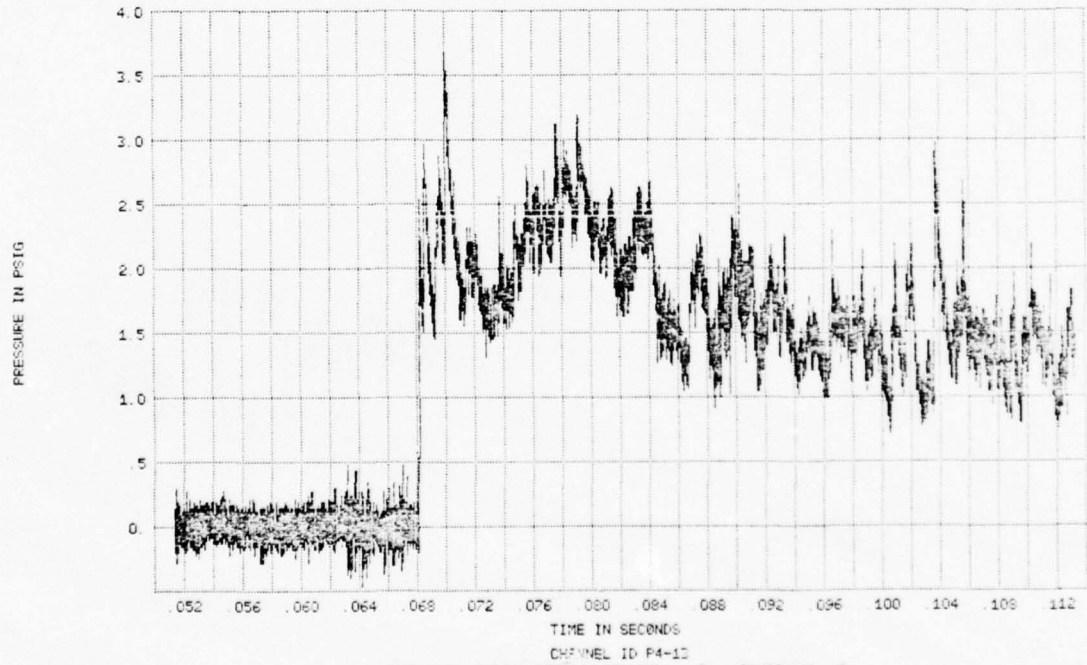


FIGURE 4-37 , SPECIMEN NO. 4 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

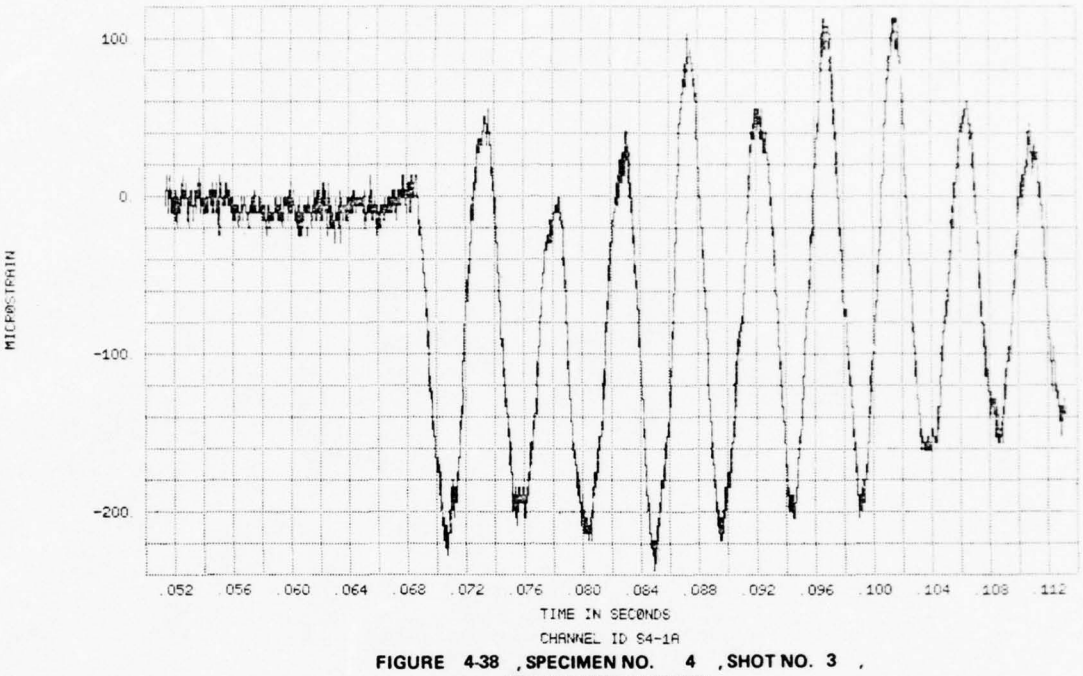


FIGURE 4-38 , SPECIMEN NO. 4 , SHOT NO. 3 ,
STRAIN TIME HISTORY

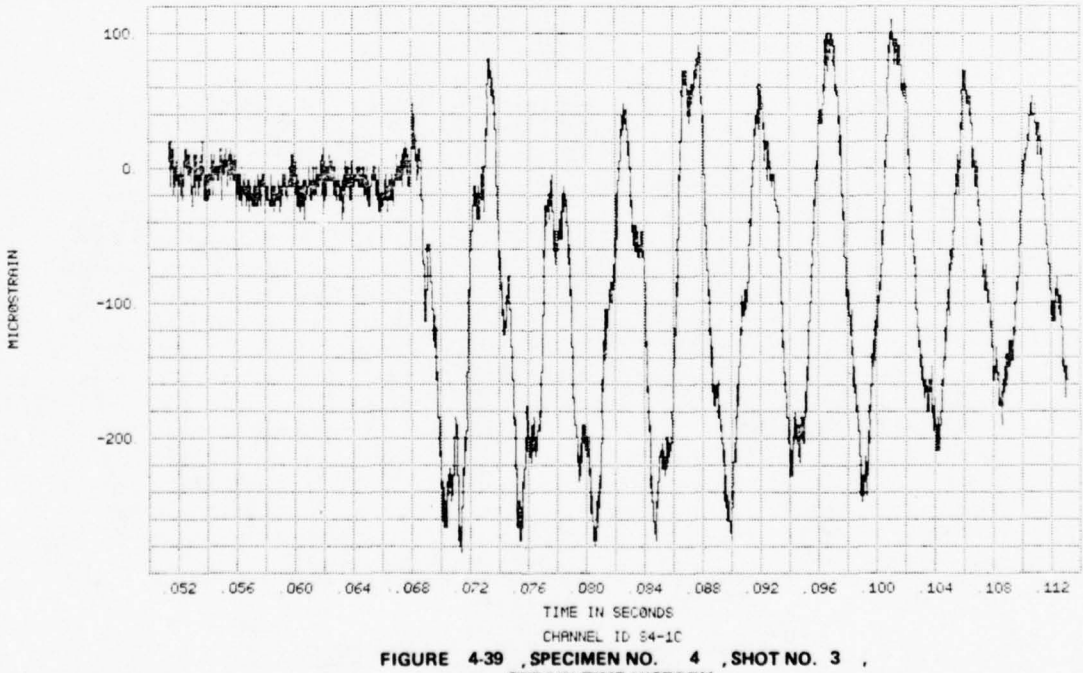


FIGURE 4-39 , SPECIMEN NO. 4 , SHOT NO. 3 ,
STRAIN TIME HISTORY

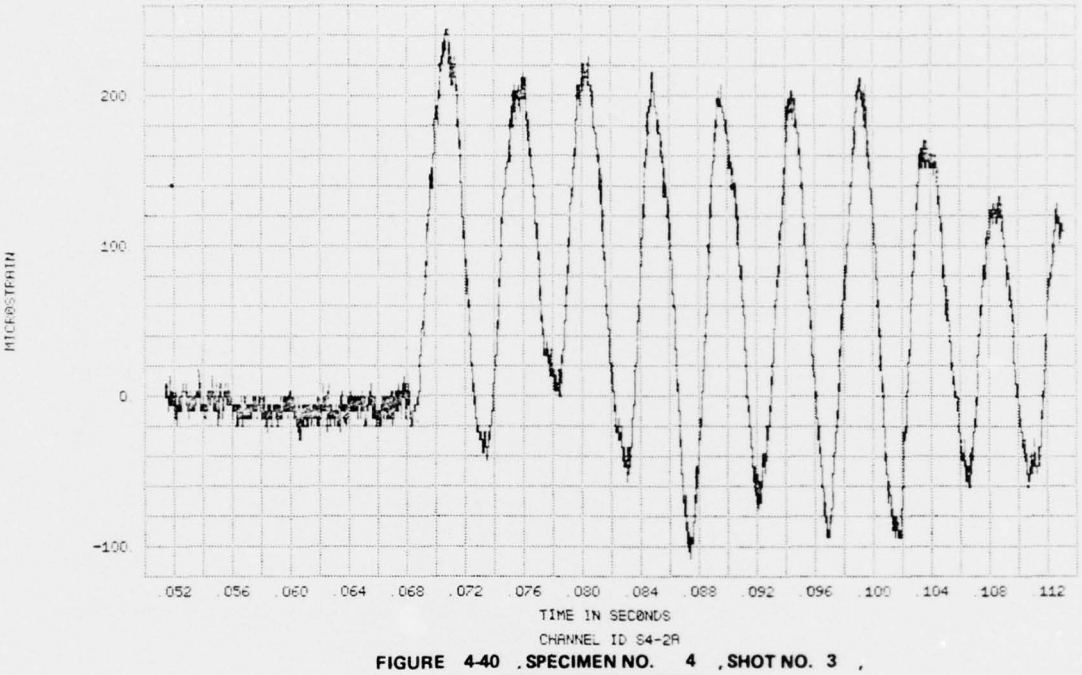


FIGURE 4-40 , SPECIMEN NO. 4 , SHOT NO. 3 , STRAIN TIME HISTORY

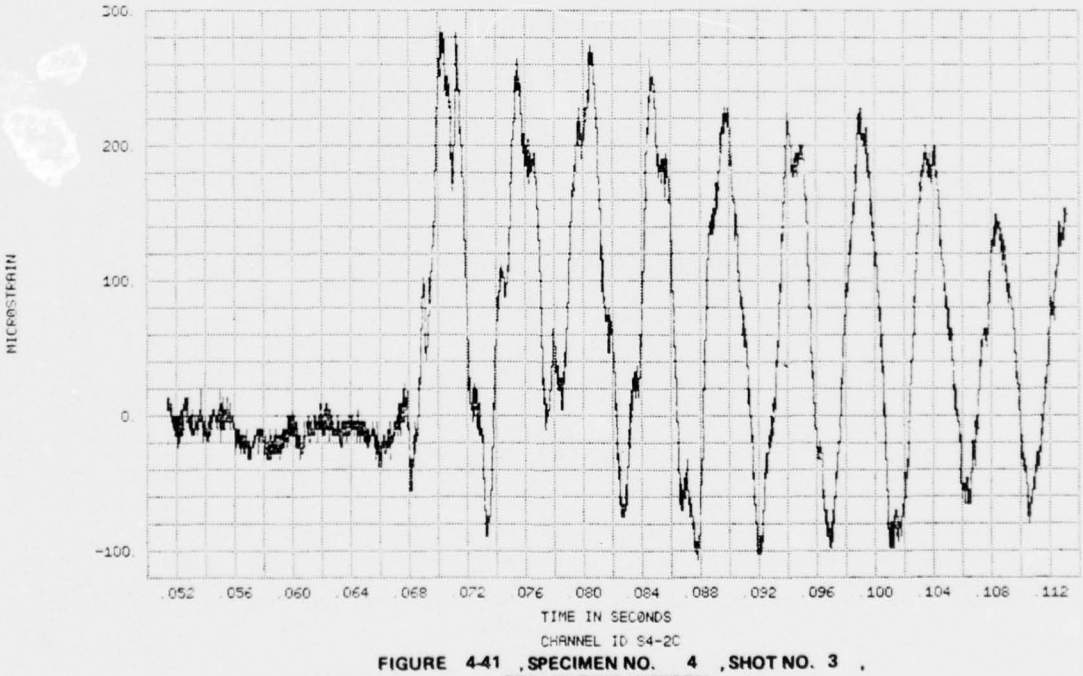


FIGURE 4-41 , SPECIMEN NO. 4 , SHOT NO. 3 , STRAIN TIME HISTORY

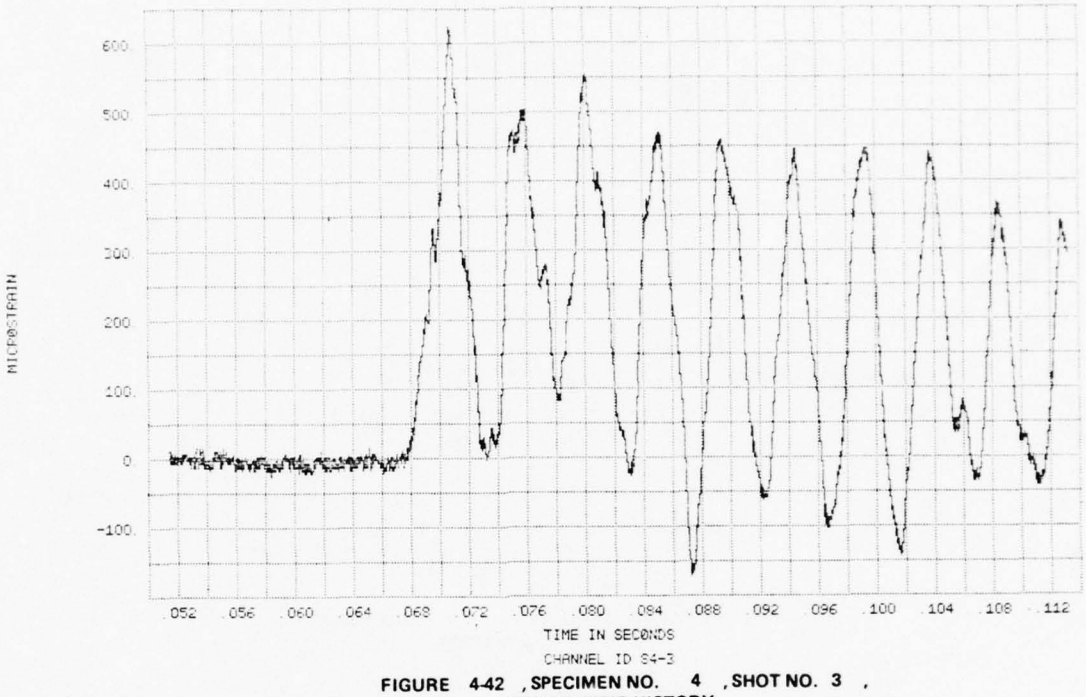


FIGURE 4-42 , SPECIMEN NO. 4 , SHOT NO. 3 , STRAIN TIME HISTORY

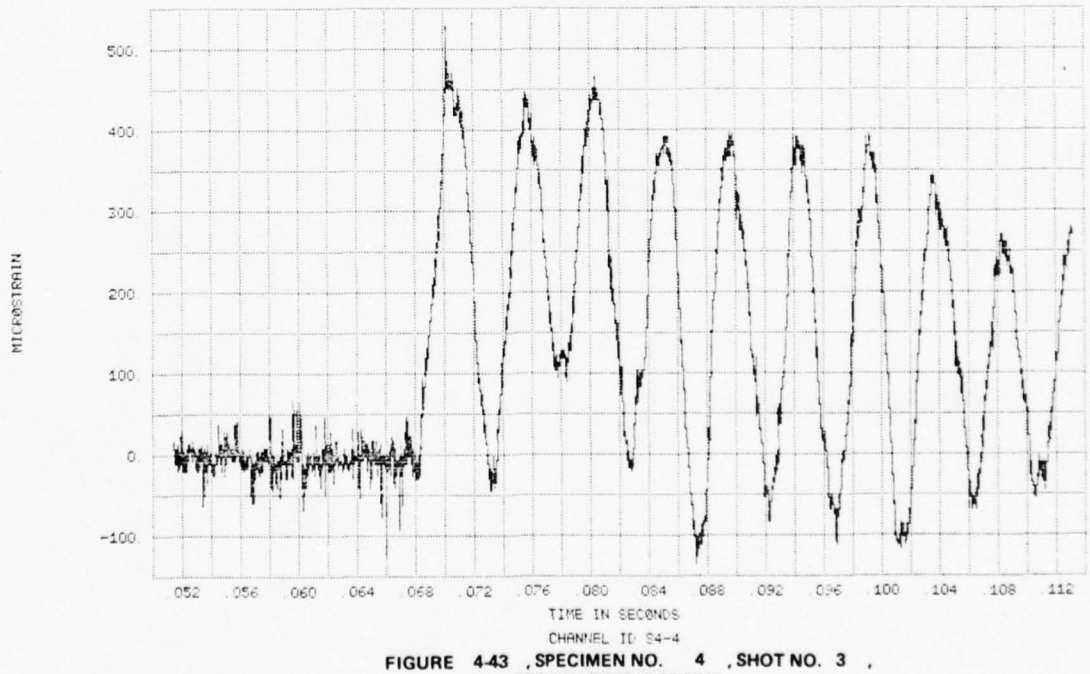


FIGURE 4-43 , SPECIMEN NO. 4 , SHOT NO. 3 , STRAIN TIME HISTORY

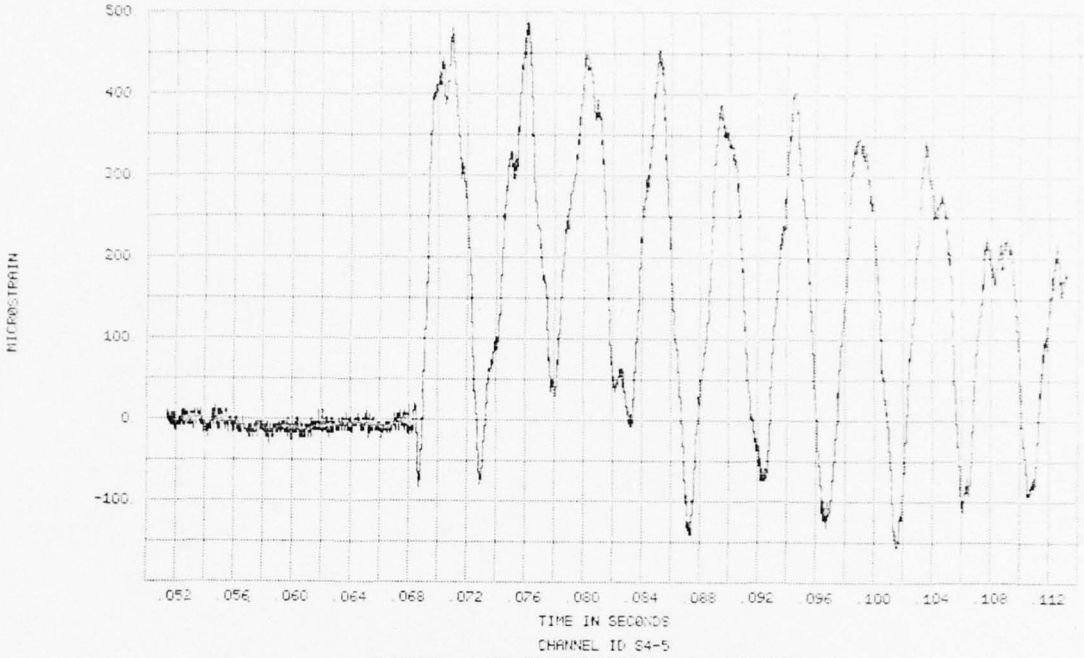


FIGURE 4-44 , SPECIMEN NO. 4 , SHOT NO. 3 ,
STRAIN TIME HISTORY

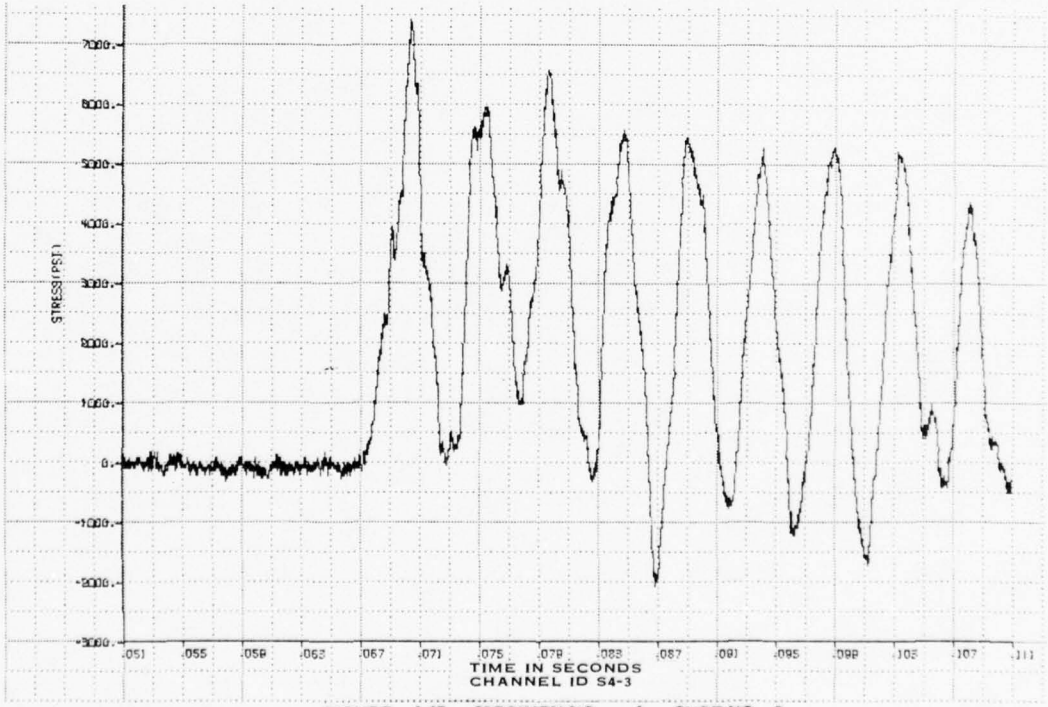


FIGURE 4-45 , SPECIMEN NO. 4 , SHOT NO. 3 ,
STRESS TIME HISTORY

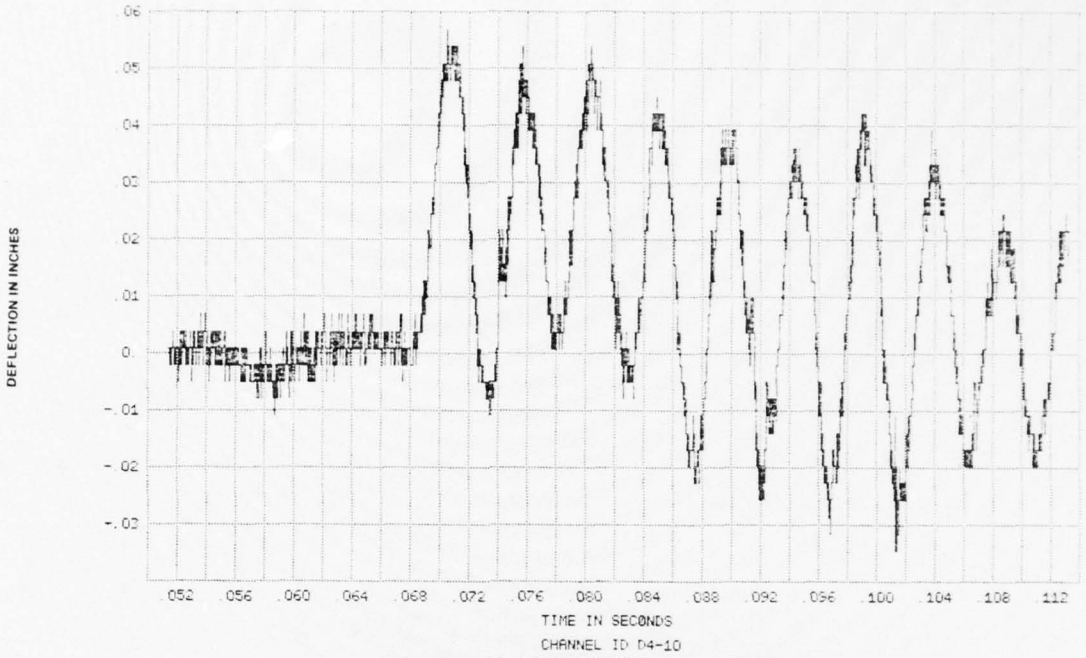


FIGURE 4-46 , SPECIMEN NO. 4 , SHOT NO. 3 ,
DEFLECTION TIME HISTORY

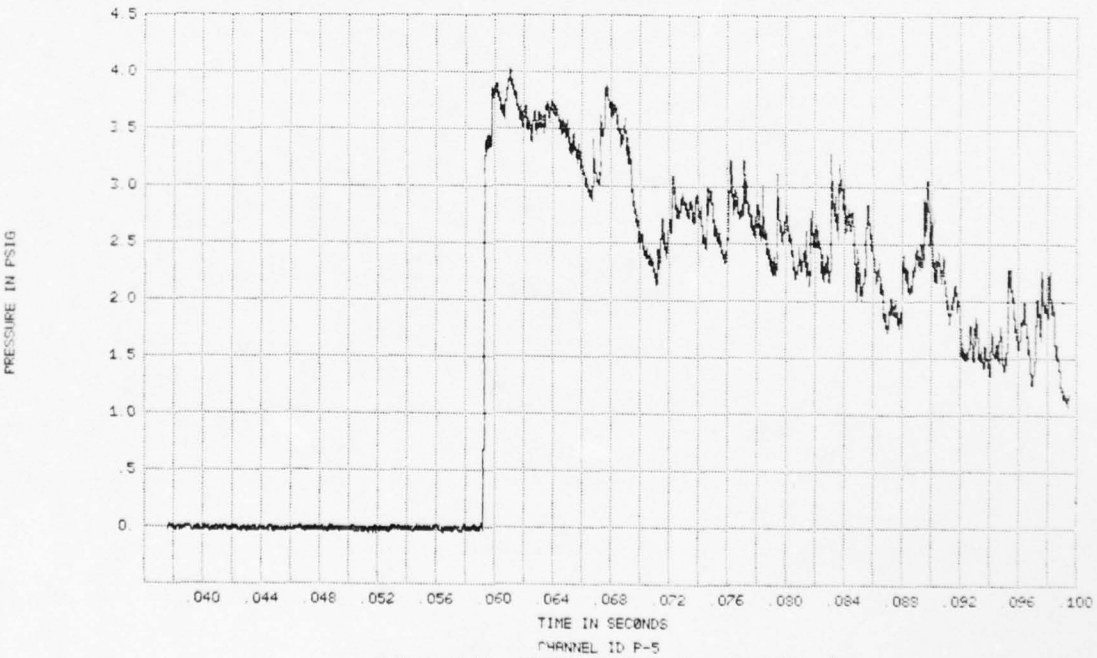


FIGURE 4-47 , SPECIMEN NO. 4 SHOT NO. 4 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

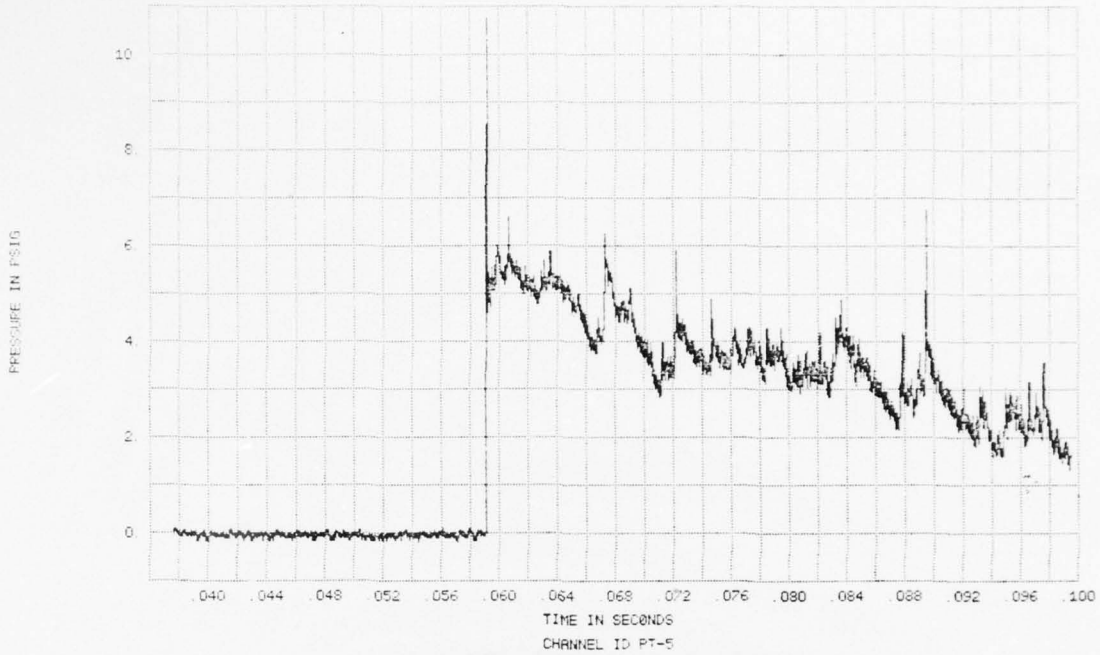


FIGURE 4-48 , SPECIMEN NO. 4 , SHOT NO. 4 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

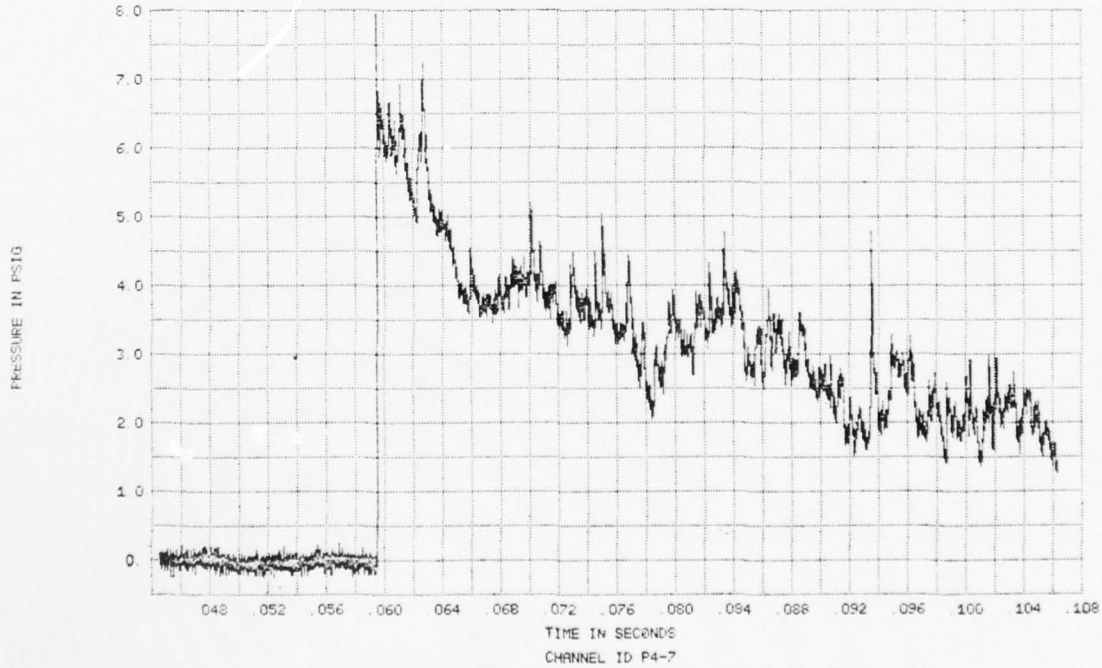


FIGURE 4-49 , SPECIMEN NO. 4 , SHOT NO. 4 ,
***SPECIMEN* REFLECTED PRESSURE TIME HISTORY**

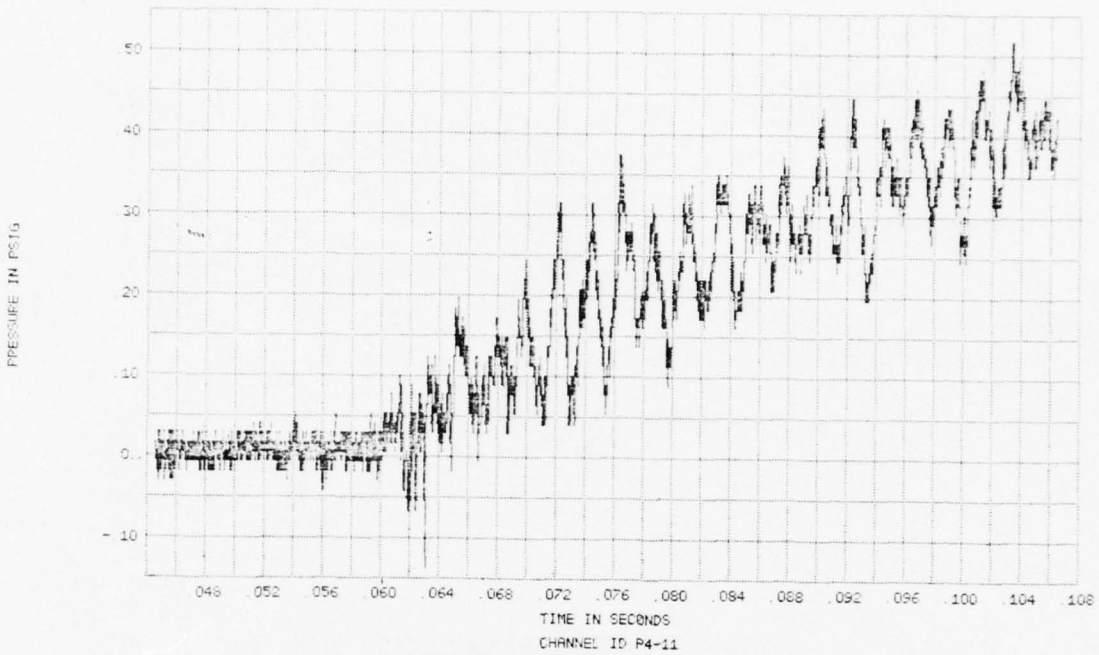


FIGURE 4-50 , SPECIMEN NO. 4 , SHOT NO. 4 ,
INTERNAL PRESSURE TIME HISTORY

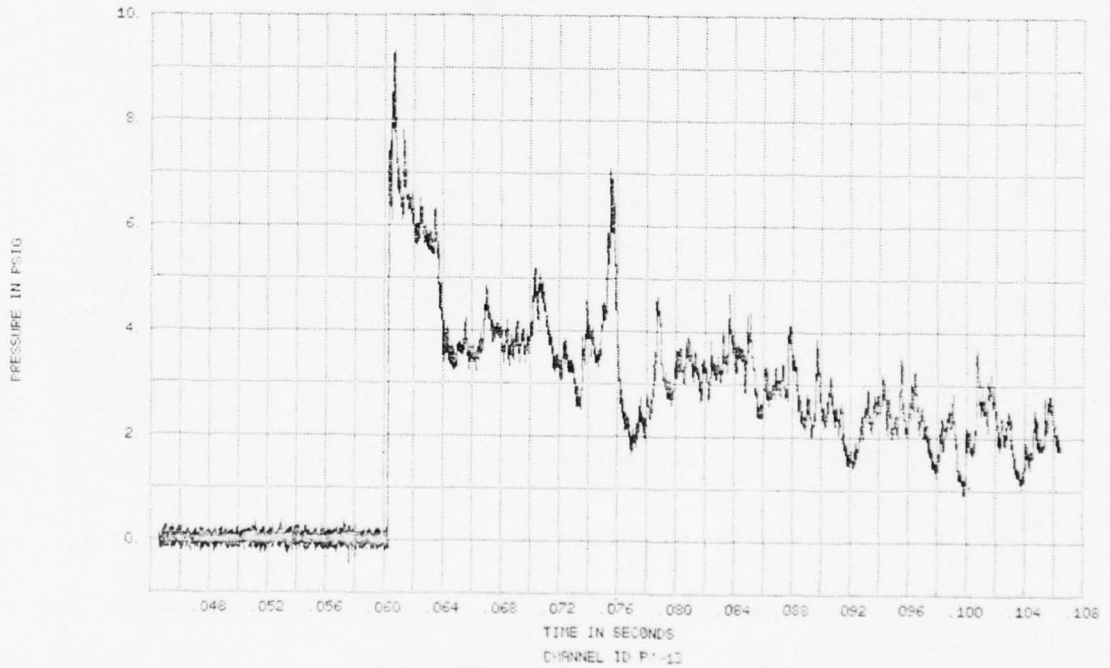


FIGURE 4-51 , SPECIMEN NO. 4 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

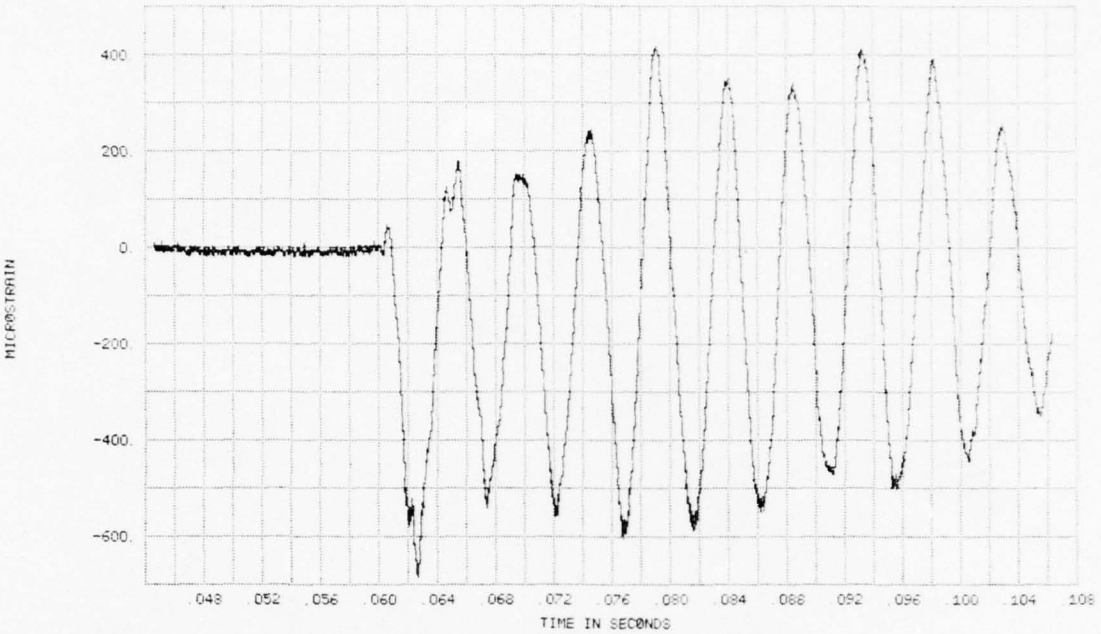


FIGURE 4-52 , SPECIMEN NO. 4 , SHOT NO. 4 , STRAIN TIME HISTORY

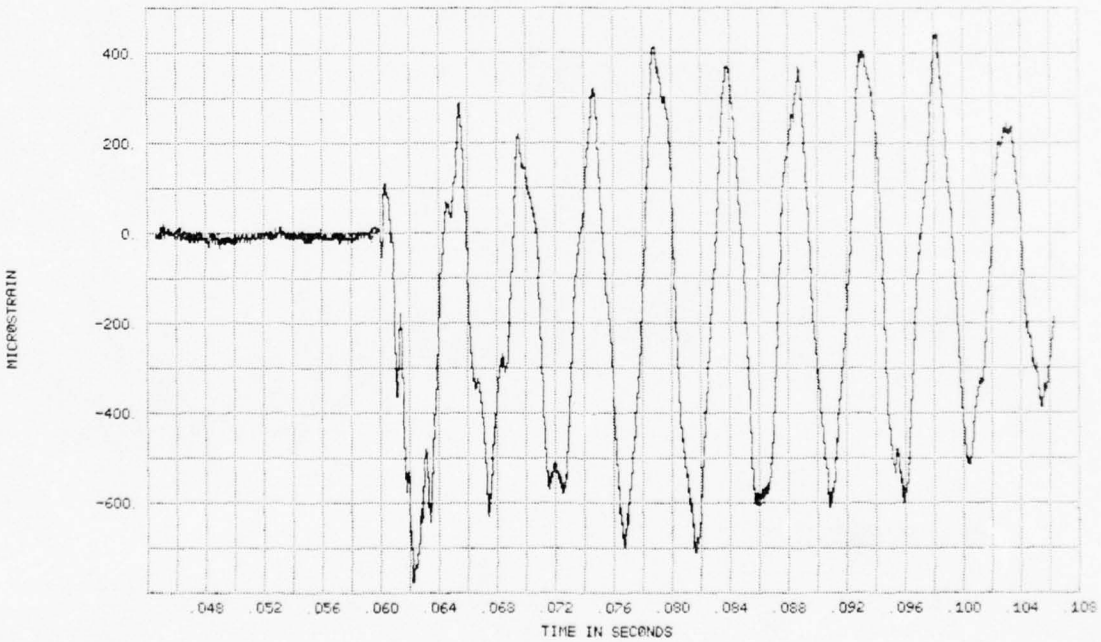


FIGURE 4-53 , SPECIMEN NO. 4 , SHOT NO. 4 , STRAIN TIME HISTORY

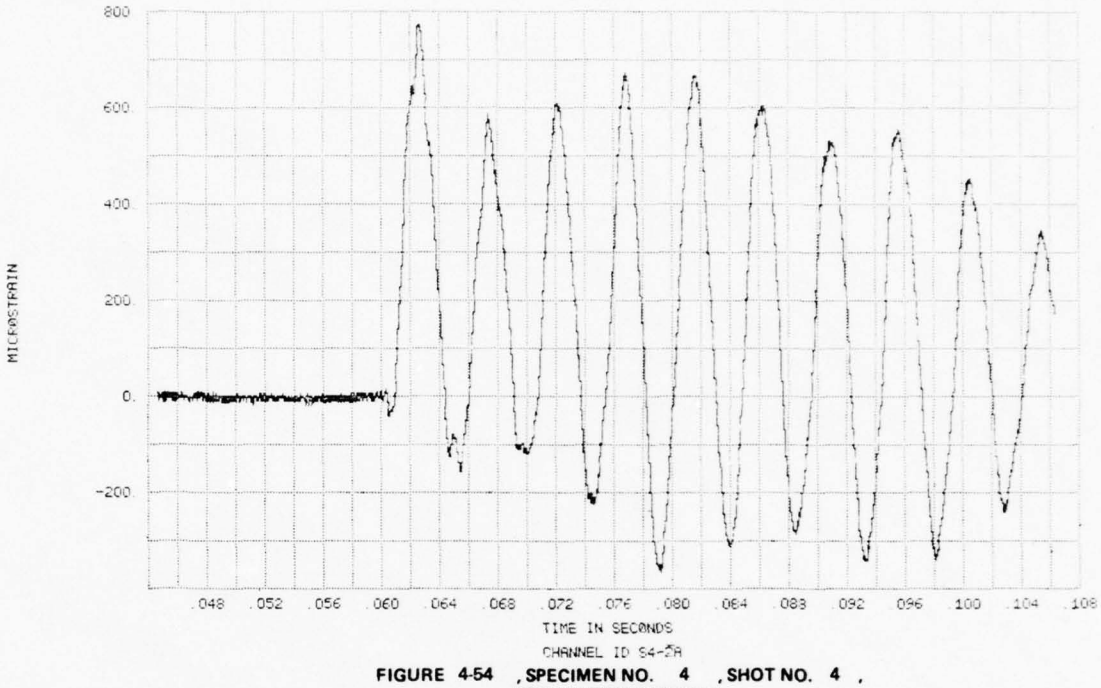


FIGURE 4-54 , SPECIMEN NO. 4 , SHOT NO. 4 , STRAIN TIME HISTORY

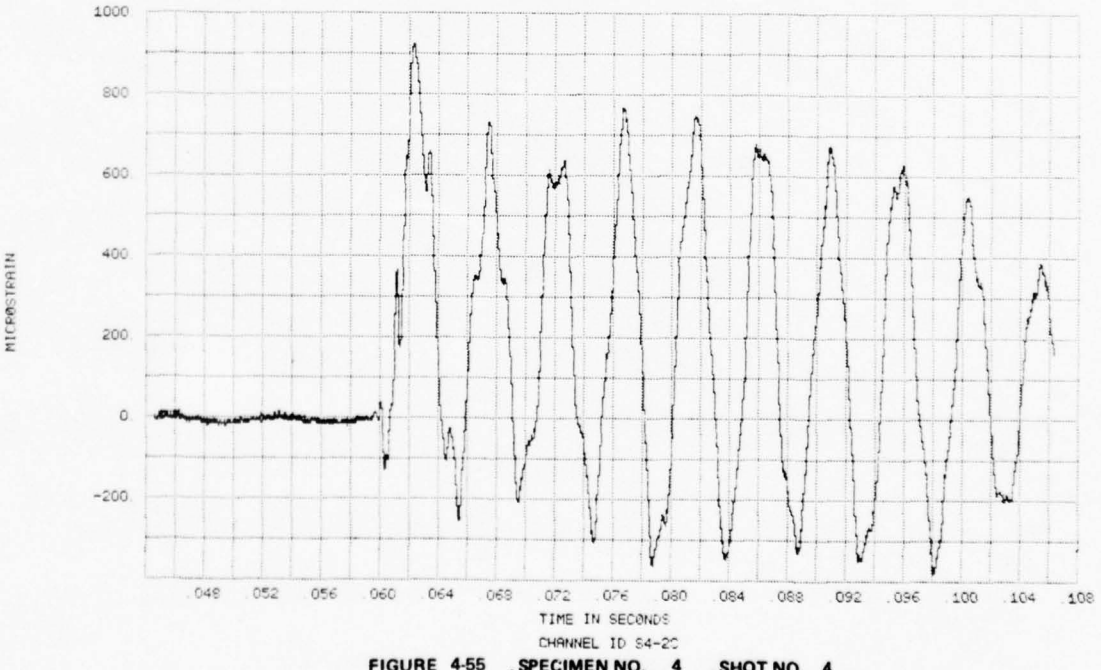


FIGURE 4-55 , SPECIMEN NO. 4 , SHOT NO. 4 , STRAIN TIME HISTORY

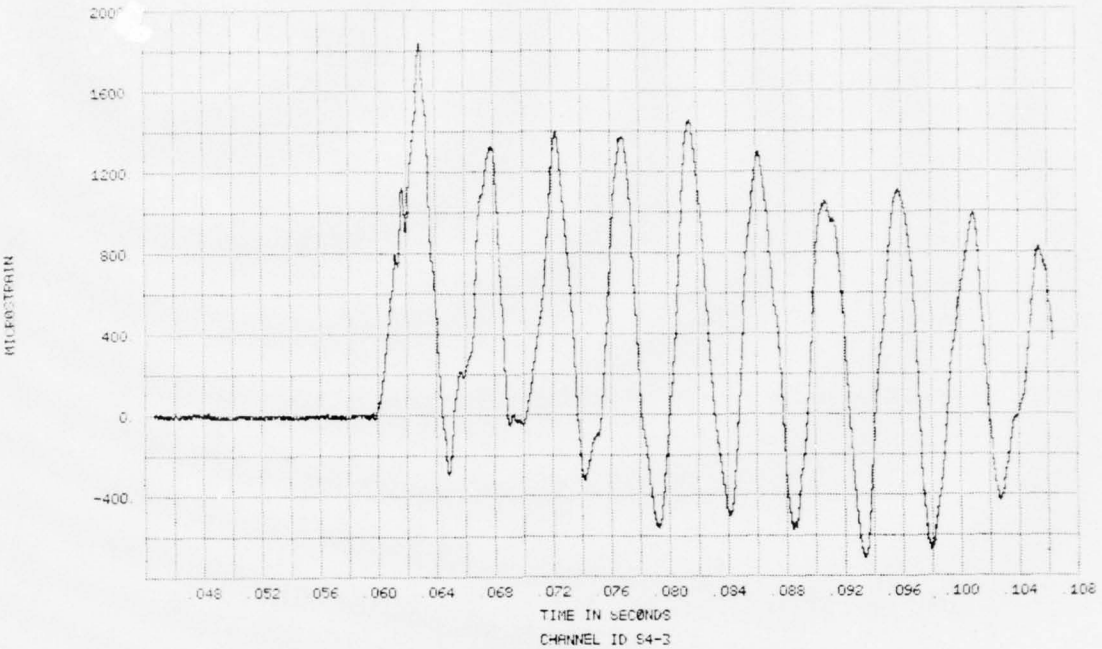


FIGURE 4-56 , SPECIMEN NO. 4 , SHOT NO. 4 , STRAIN TIME HISTORY

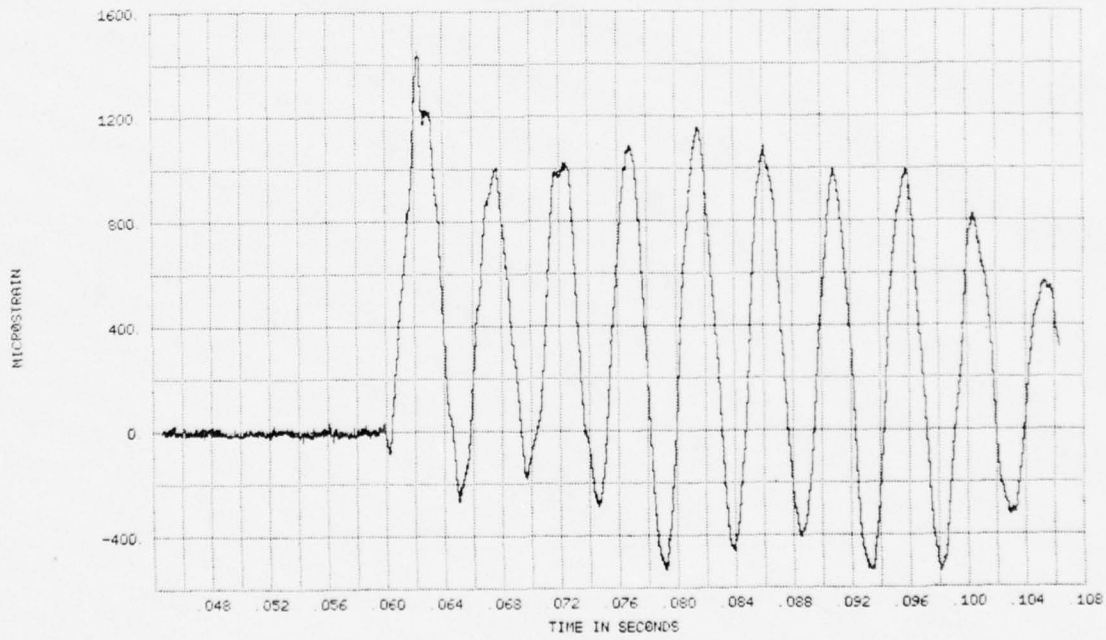


FIGURE 4-57 , SPECIMEN NO. 4 , SHOT NO. 4 , STRAIN TIME HISTORY

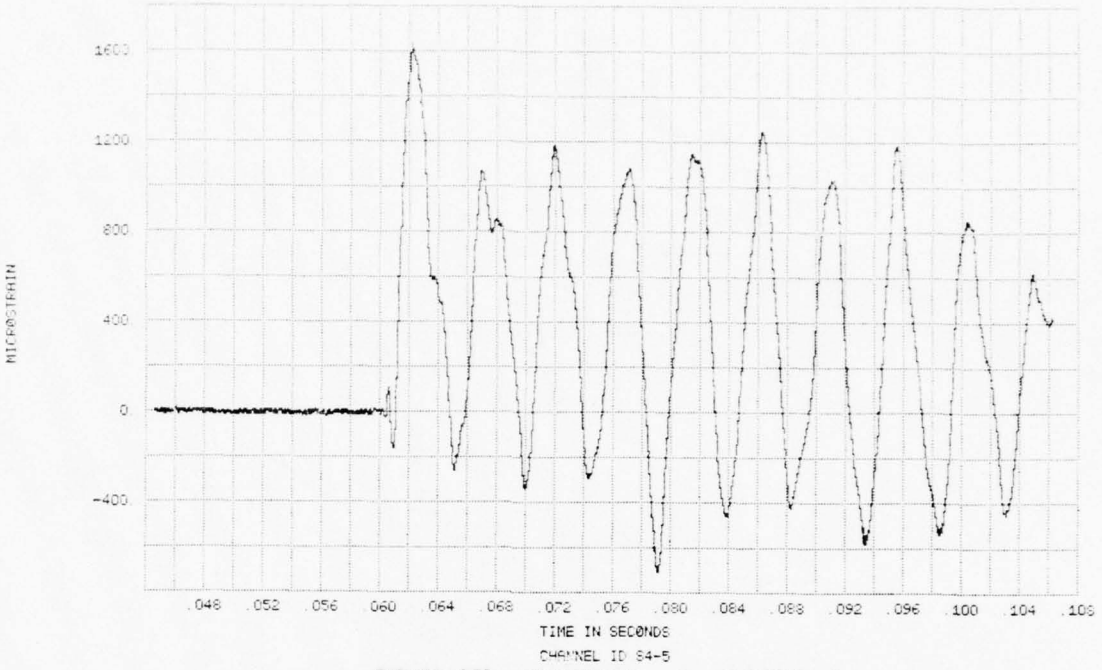


FIGURE 4-58 , SPECIMEN NO. 4 , SHOT NO. 4 ,
STRAIN TIME HISTORY

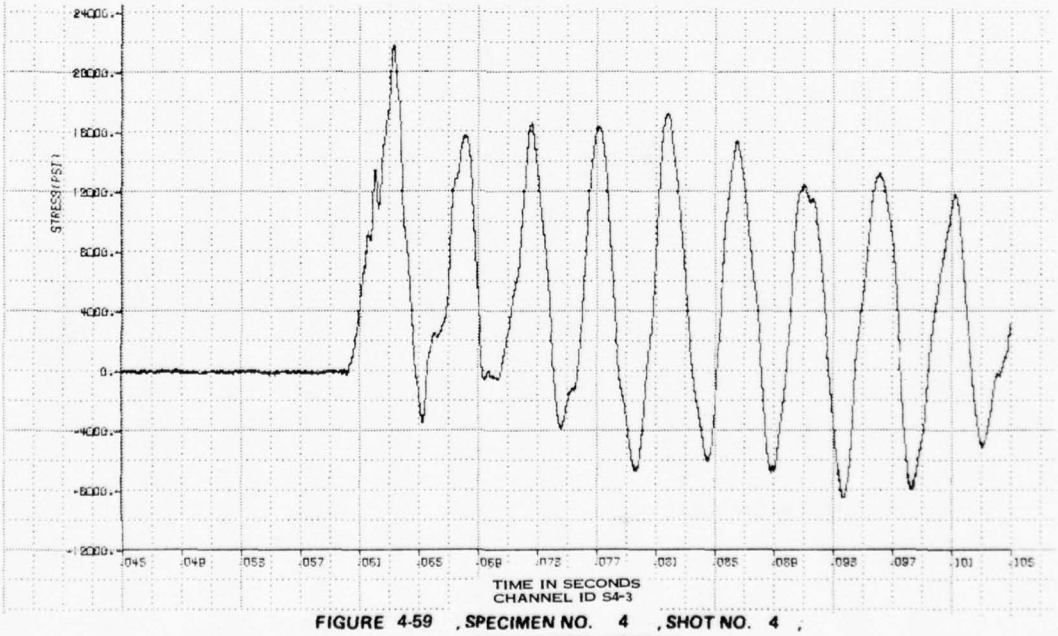


FIGURE 4-59 , SPECIMEN NO. 4 , SHOT NO. 4 ,
STRESS TIME HISTORY

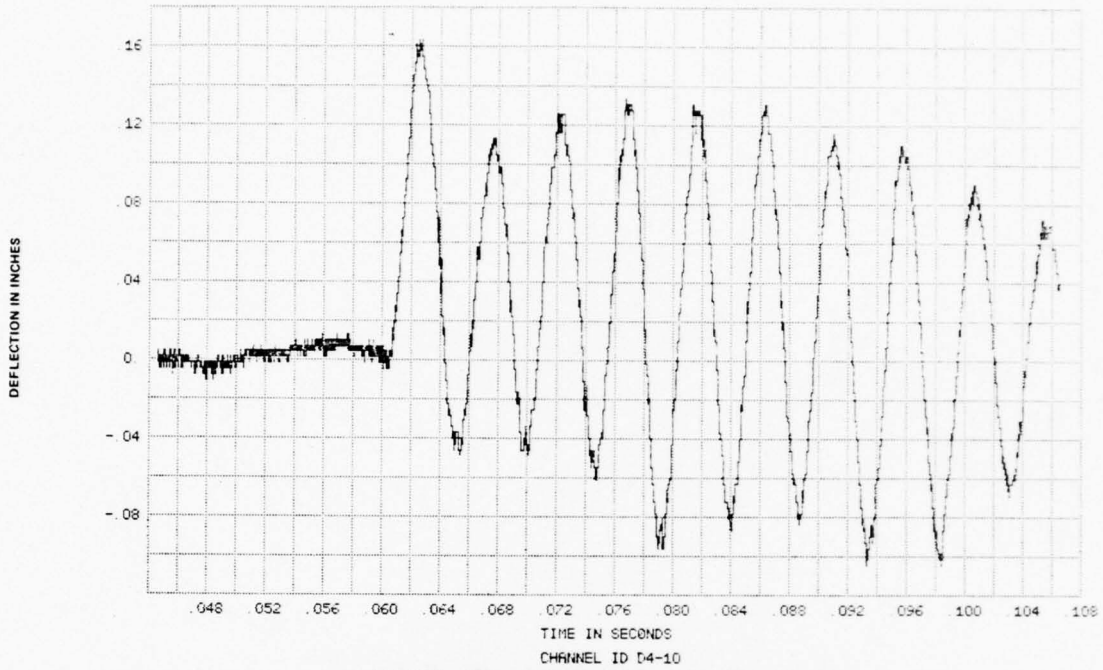


FIGURE 4-60 , SPECIMEN NO. 4 , SHOT NO. 4 , DEFLECTION TIME HISTORY

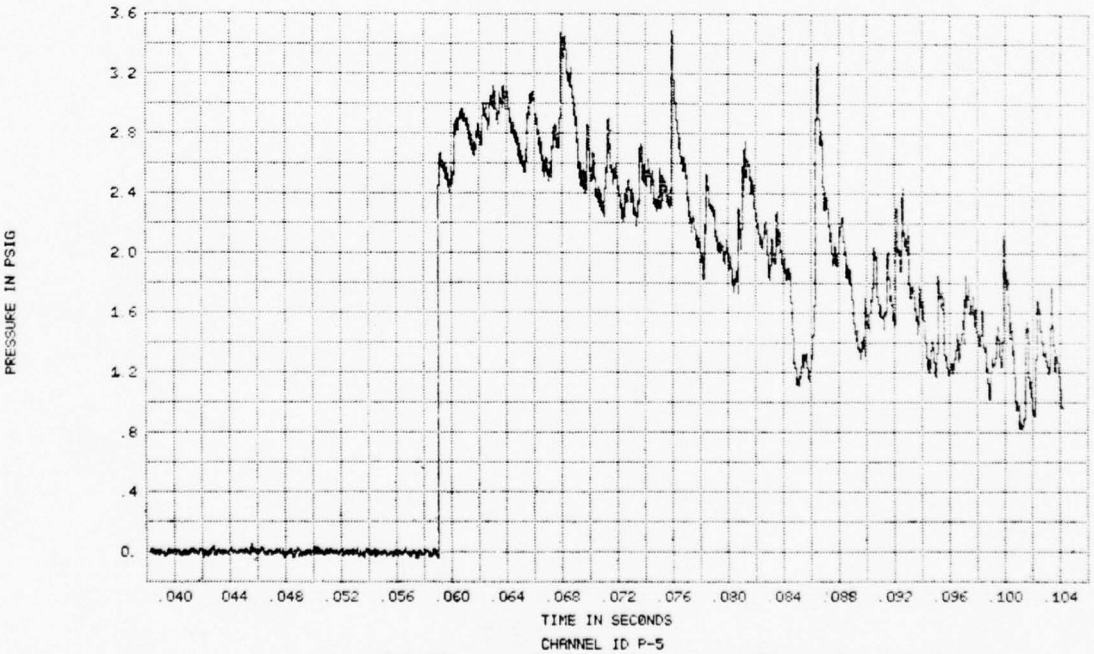


FIGURE 4-61 , SPECIMEN NO. 4 , SHOT NO. 5 , TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

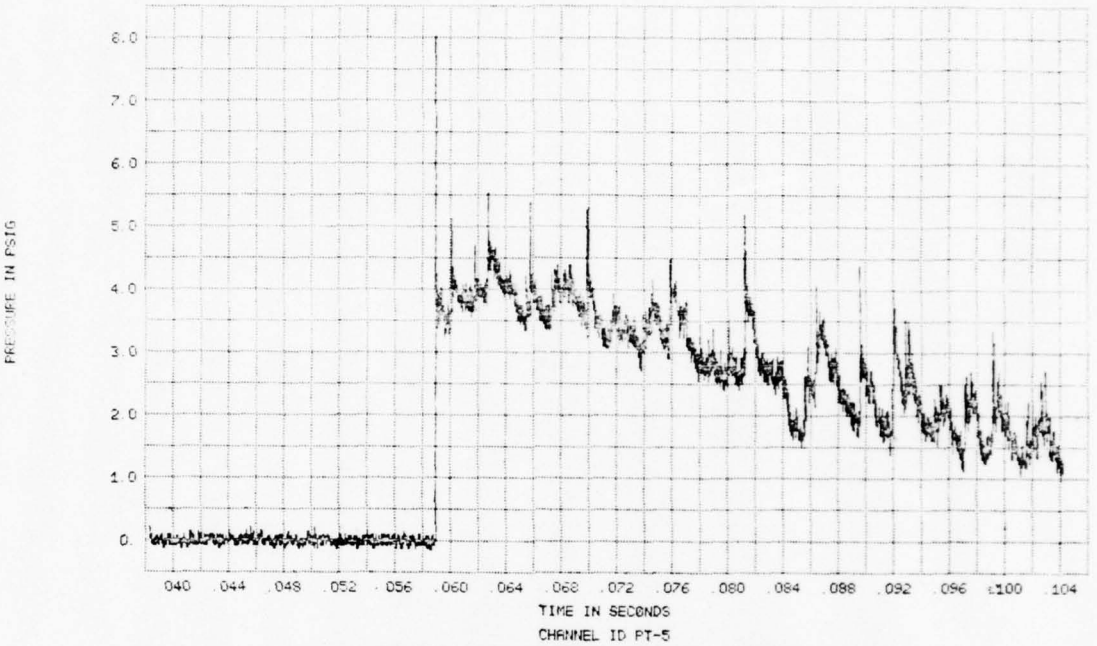


FIGURE 4-62 , SPECIMEN NO. 4 , SHOT NO. 5 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

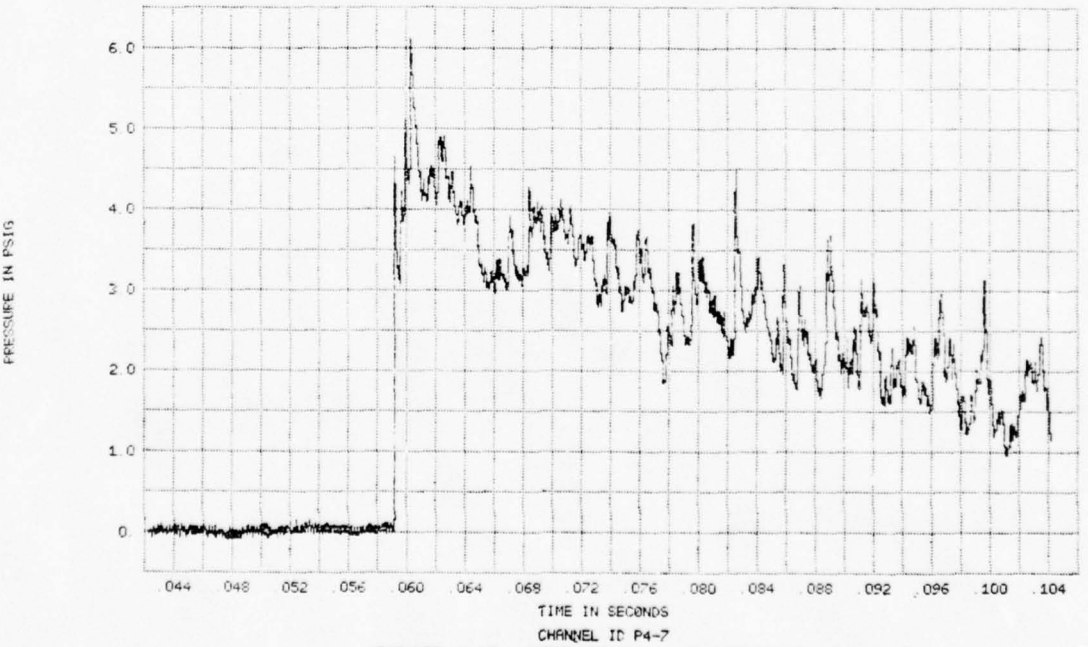


FIGURE 4-63 , SPECIMEN NO. 4 , SHOT NO. 5 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

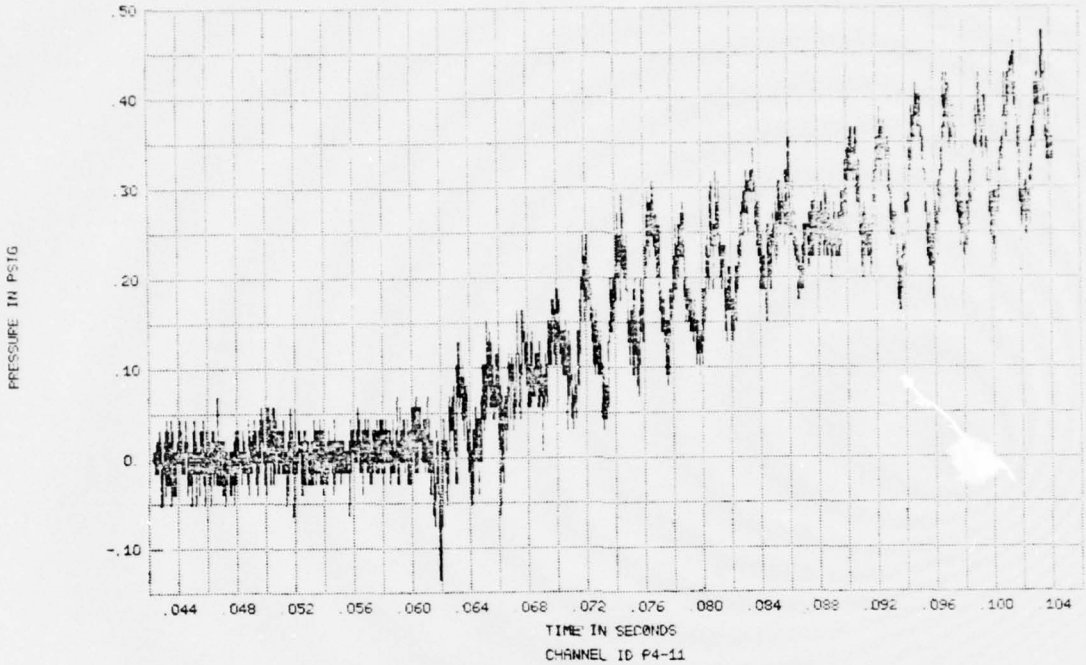


FIGURE 4-64 , SPECIMEN NO. 4 , SHOT NO. 5 ,
INTERNAL PRESSURE TIME HISTORY

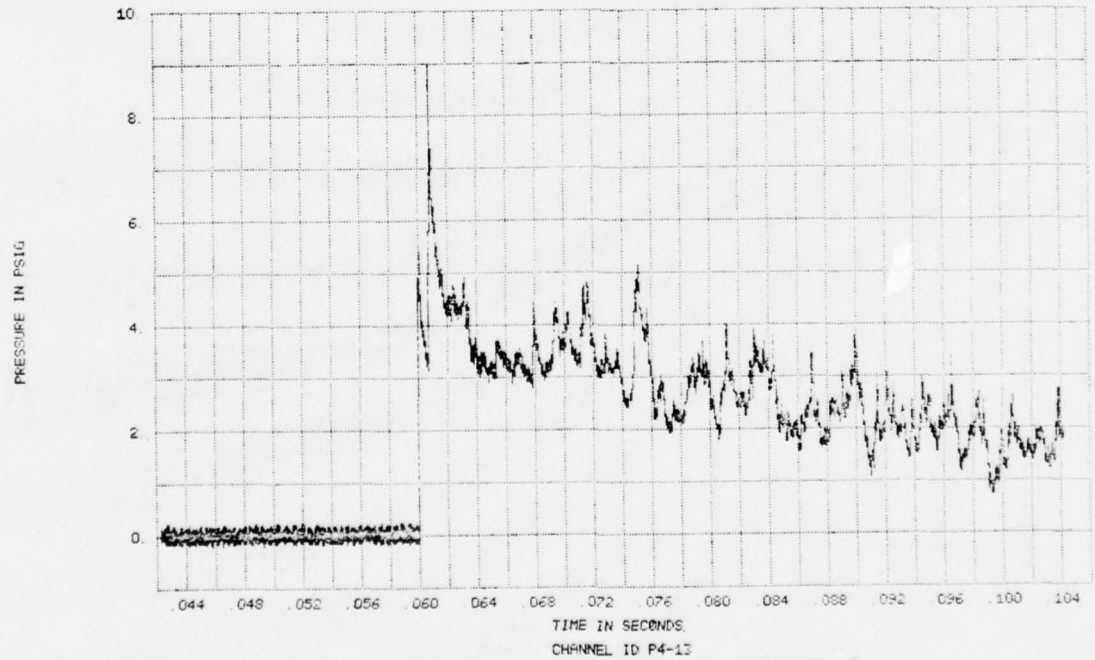


FIGURE 4-65 , SPECIMEN NO. 4 , SHOT NO. 5 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

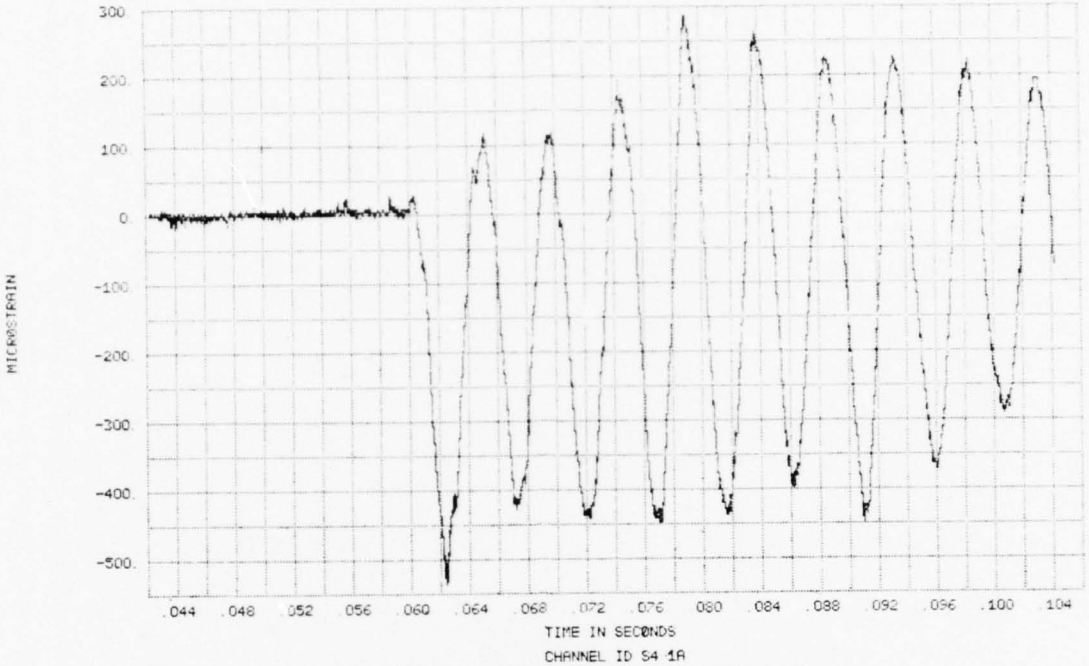


FIGURE 4-66 , SPECIMEN NO. 4 , SHOT NO. 5 , STRAIN TIME HISTORY

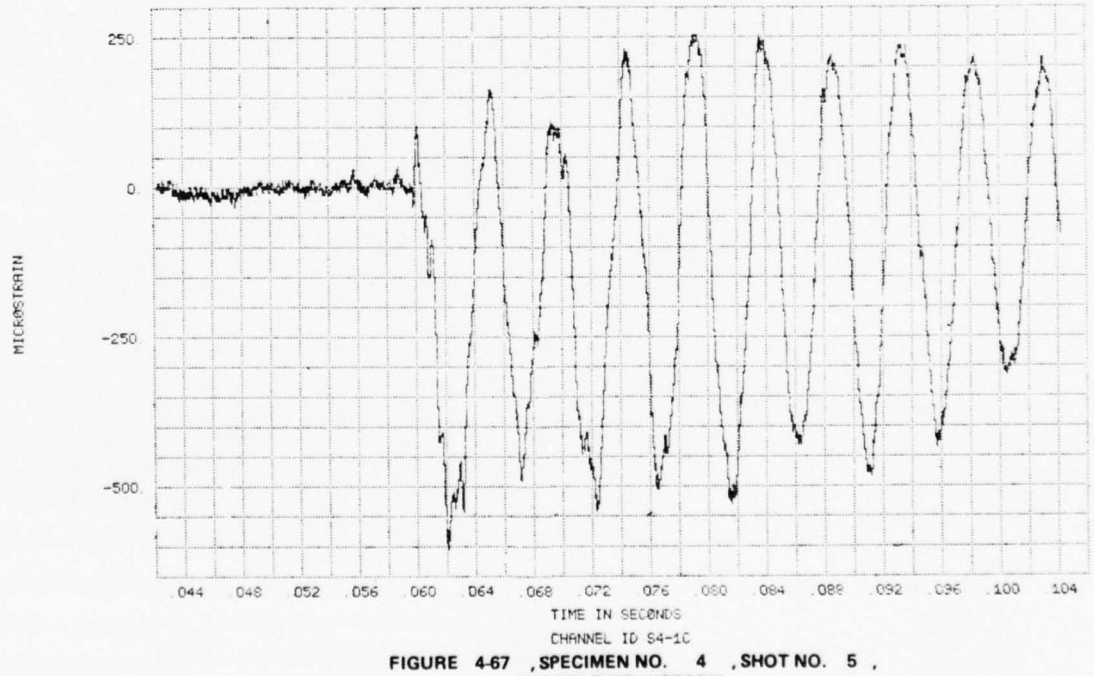


FIGURE 4-67 , SPECIMEN NO. 4 , SHOT NO. 5 , STRAIN TIME HISTORY

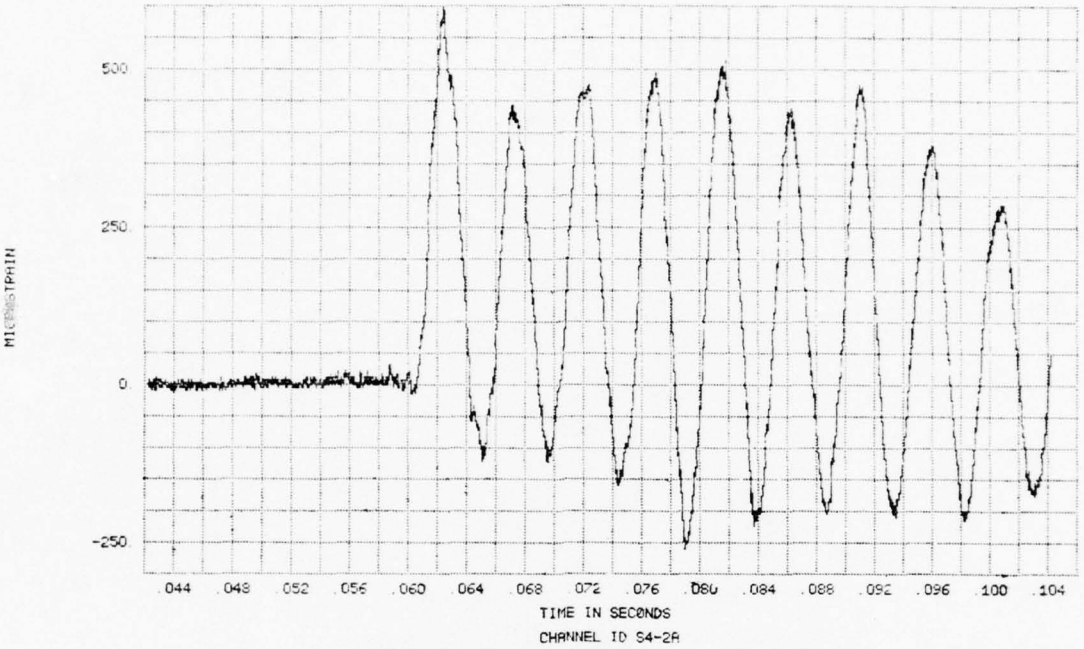


FIGURE 4-68 , SPECIMEN NO. 4 , SHOT NO. 5 , STRAIN TIME HISTORY

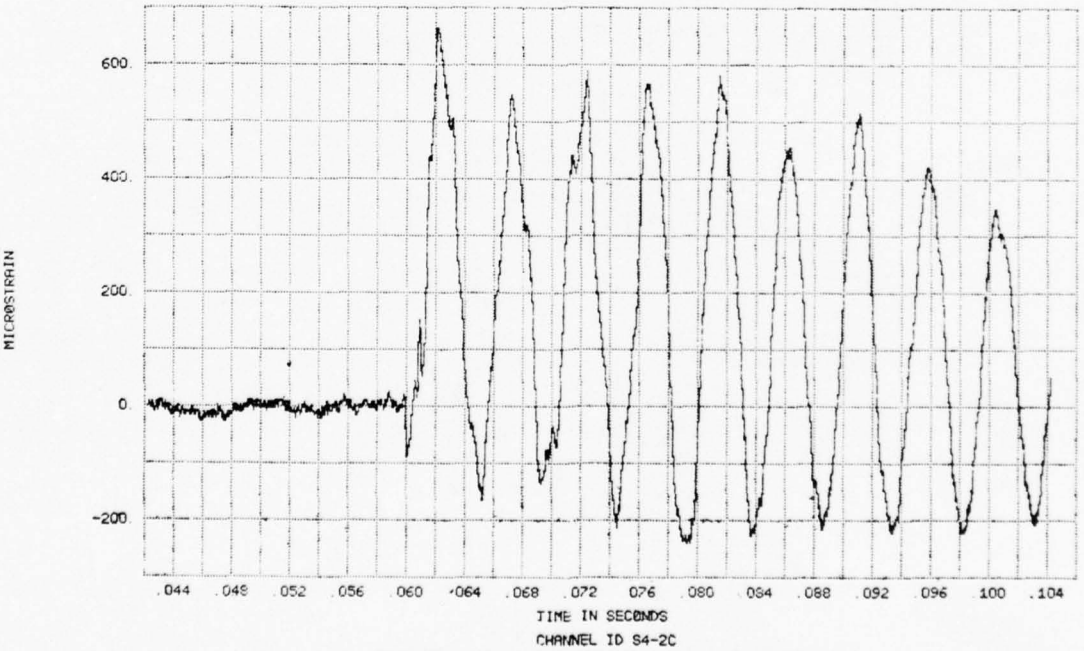


FIGURE 4-69 , SPECIMEN NO. 4 , SHOT NO. 5 STRAIN TIME HISTORY

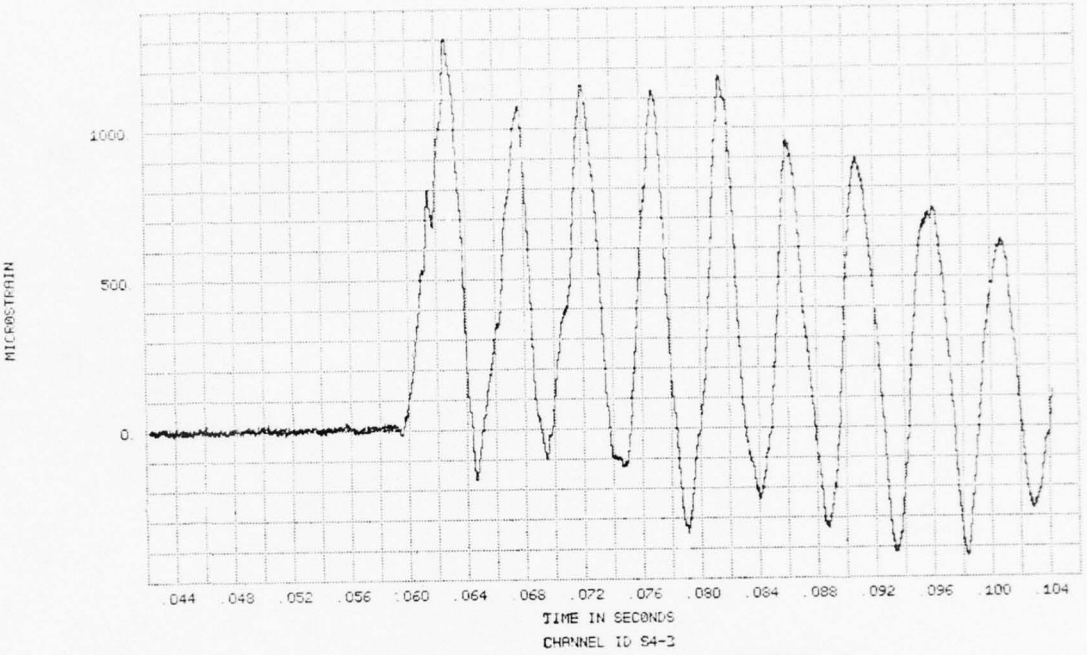


FIGURE 4-70 , SPECIMEN NO. 4 , SHOT NO. 5 , STRAIN TIME HISTORY

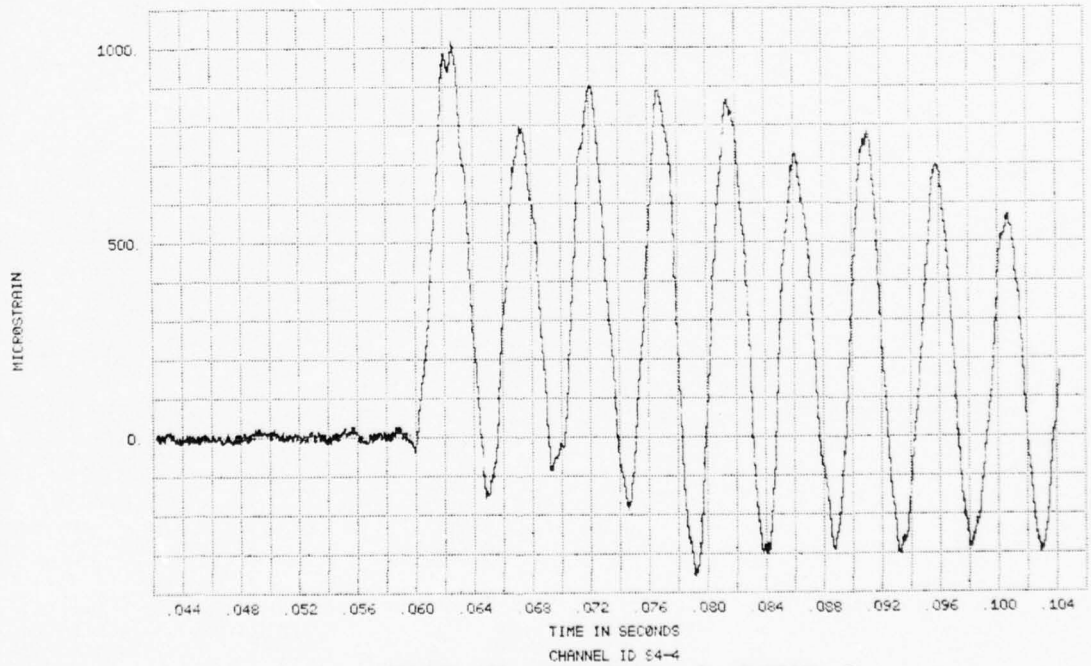


FIGURE 4-71 , SPECIMEN NO. 4 , SHOT NO. 5 , STRAIN TIME HISTORY

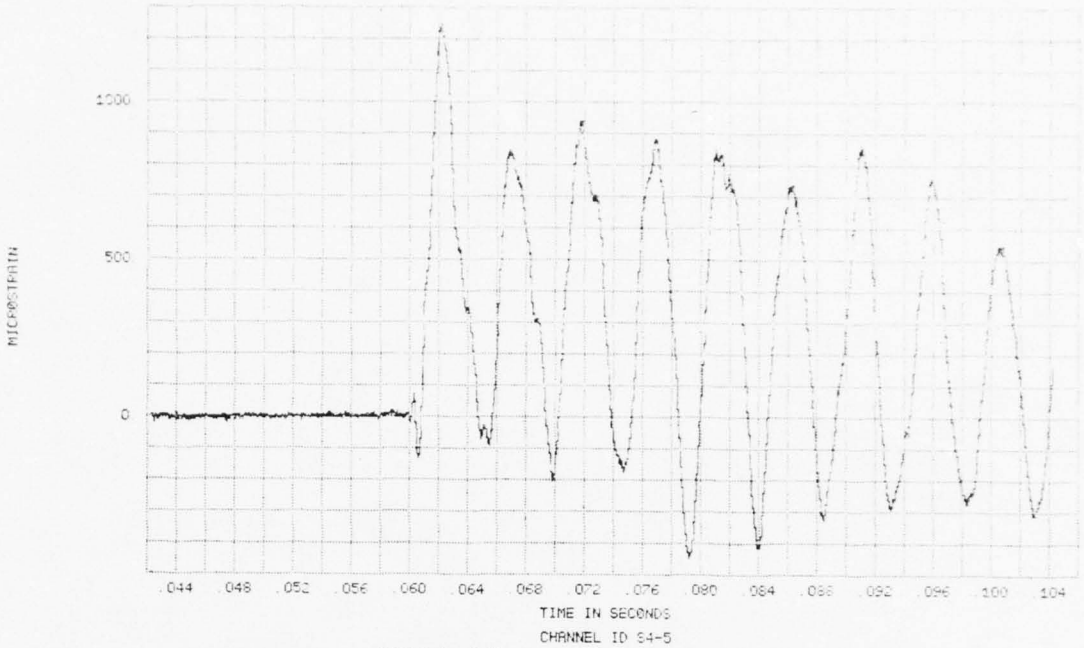


FIGURE 4-72 , SPECIMEN NO. 4 , SHOT NO. 5 ,
STRAIN TIME HISTORY

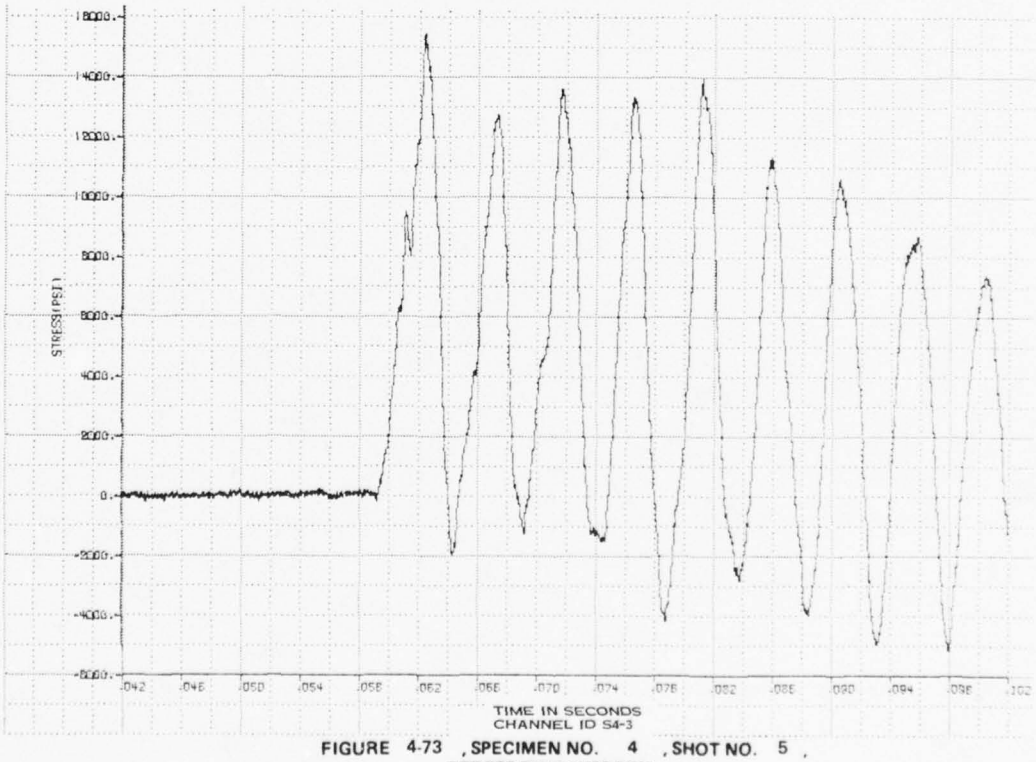


FIGURE 4-73 , SPECIMEN NO. 4 , SHOT NO. 5 ,
STRESS TIME HISTORY

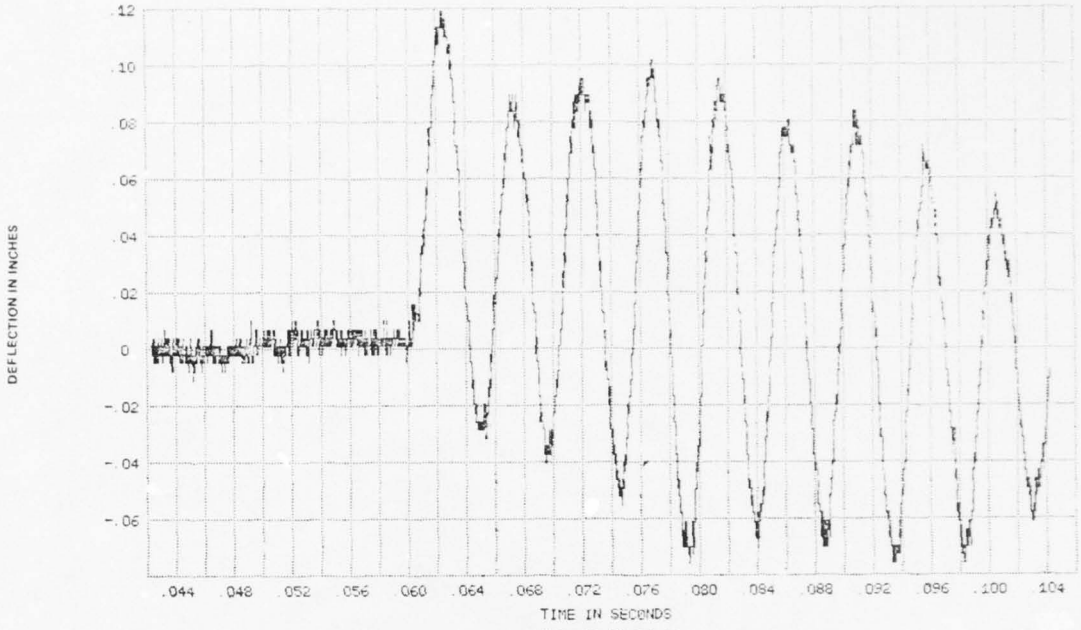


FIGURE 4-74 , SPECIMEN NO. 4 , SHOT NO. 5 ,
DEFLECTION TIME HISTORY

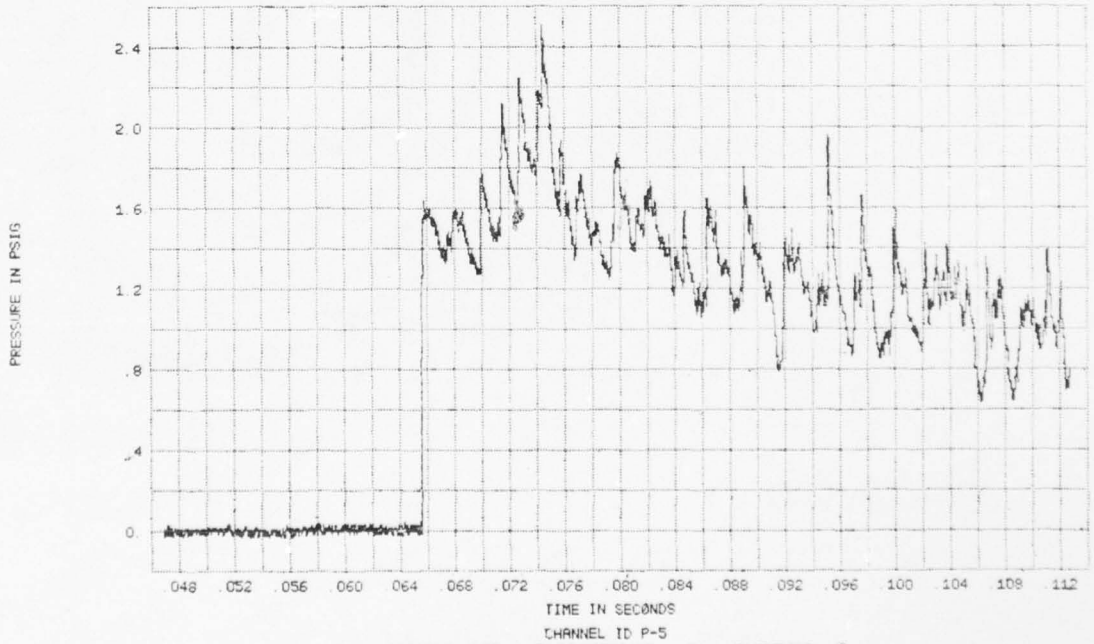


FIGURE 4-75 , SPECIMEN NO. 4 , SHOT NO. 6 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

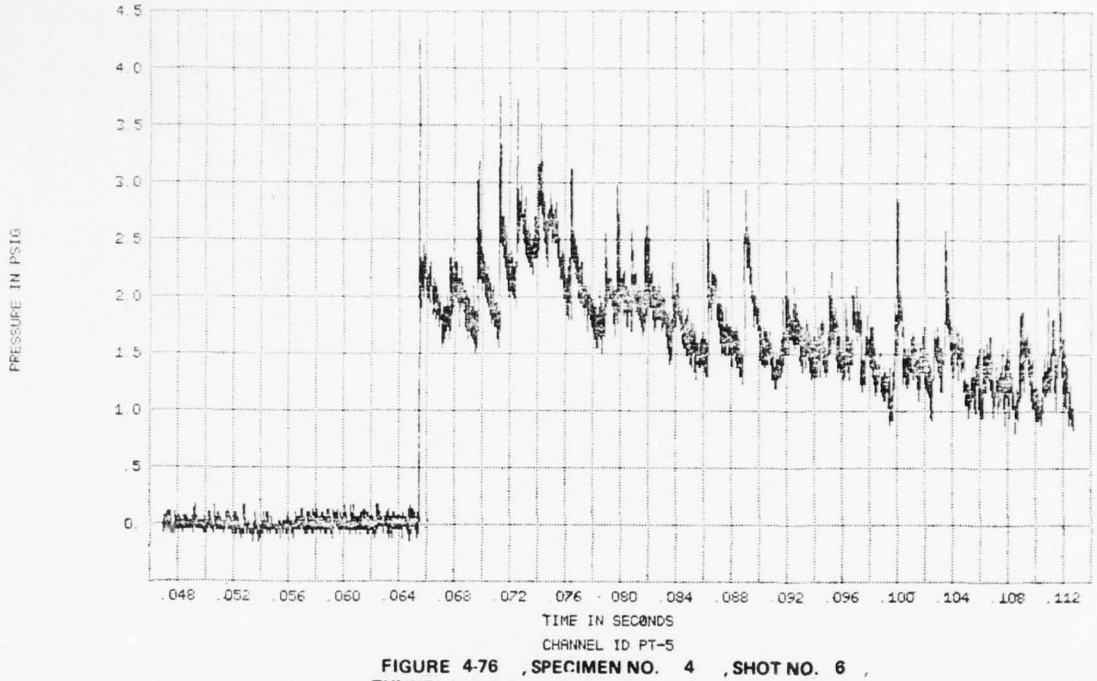


FIGURE 4-76 , SPECIMEN NO. 4 , SHOT NO. 6 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

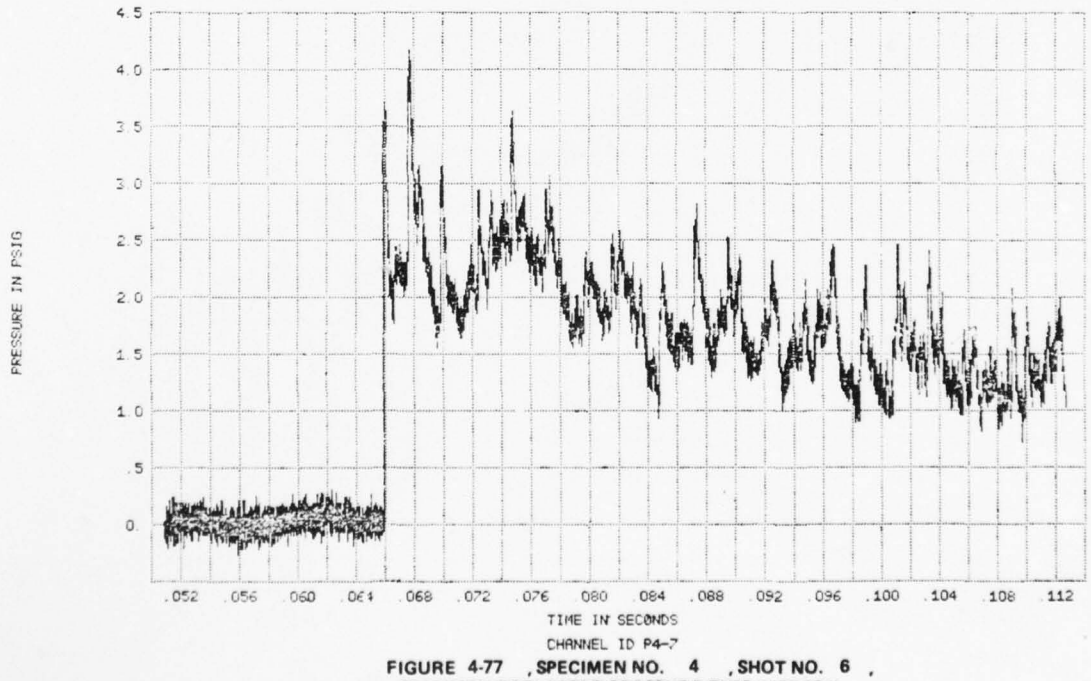


FIGURE 4-77 , SPECIMEN NO. 4 , SHOT NO. 6 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

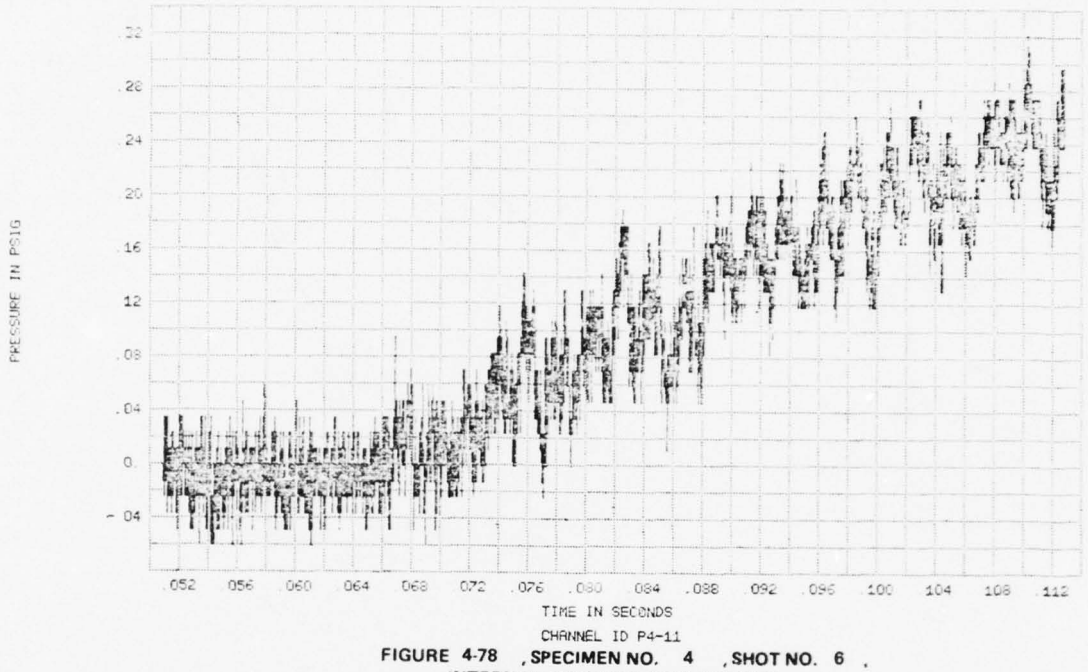


FIGURE 4-78 , SPECIMEN NO. 4 , SHOT NO. 6 ,
INTERNAL PRESSURE TIME HISTORY

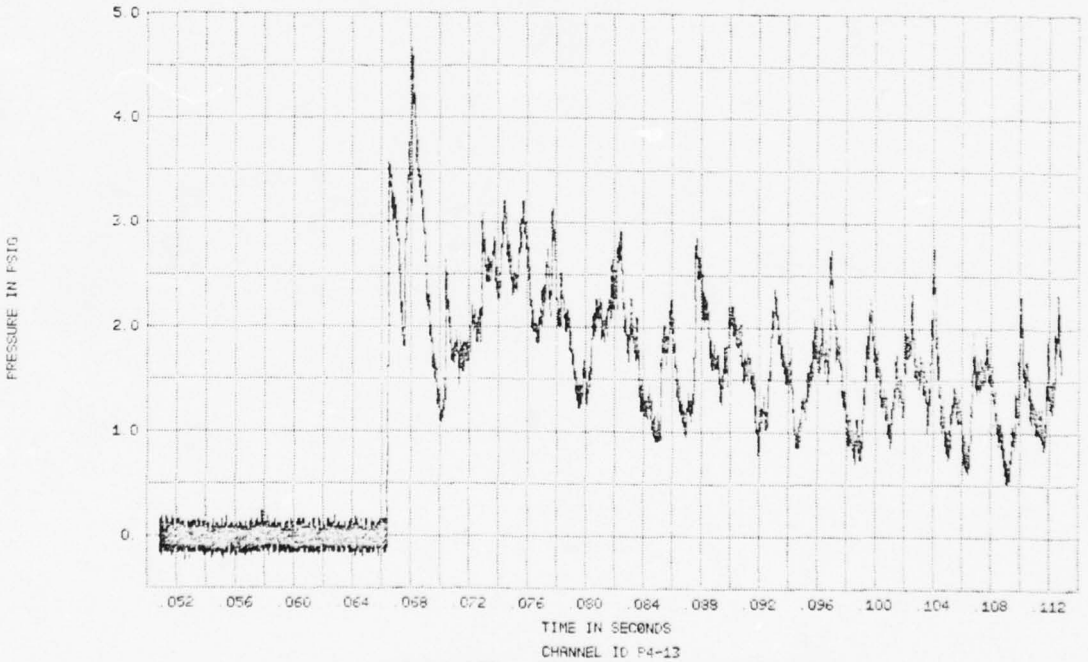


FIGURE 4-79 , SPECIMEN NO. 4 , SHOT NO. 6 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

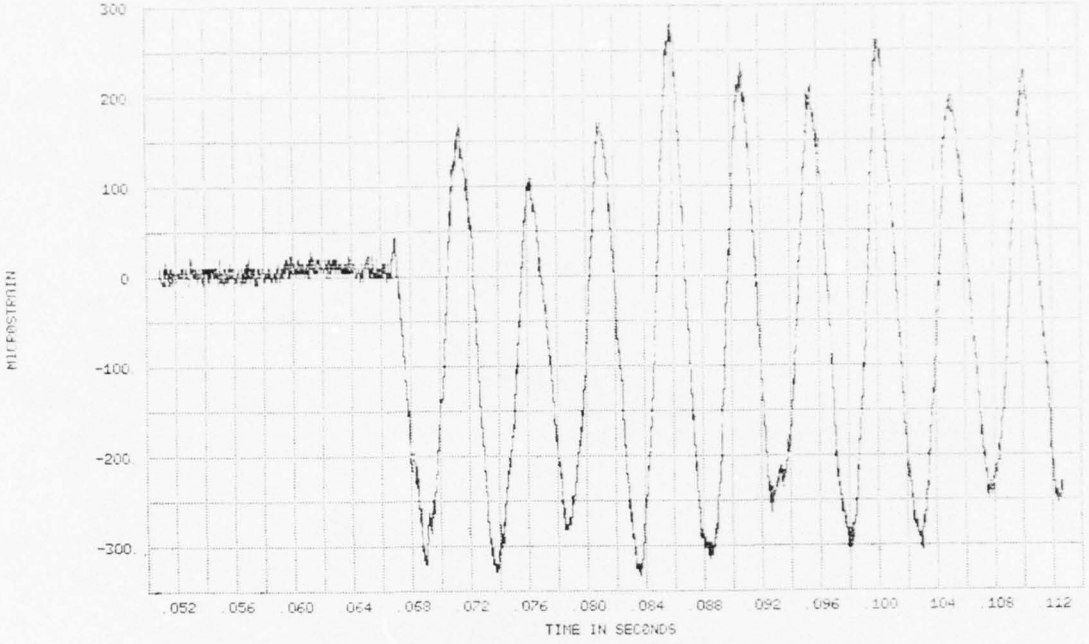


FIGURE 4-80 , SPECIMEN NO. 4 , SHOT NO. 6 ,
STRAIN TIME HISTORY

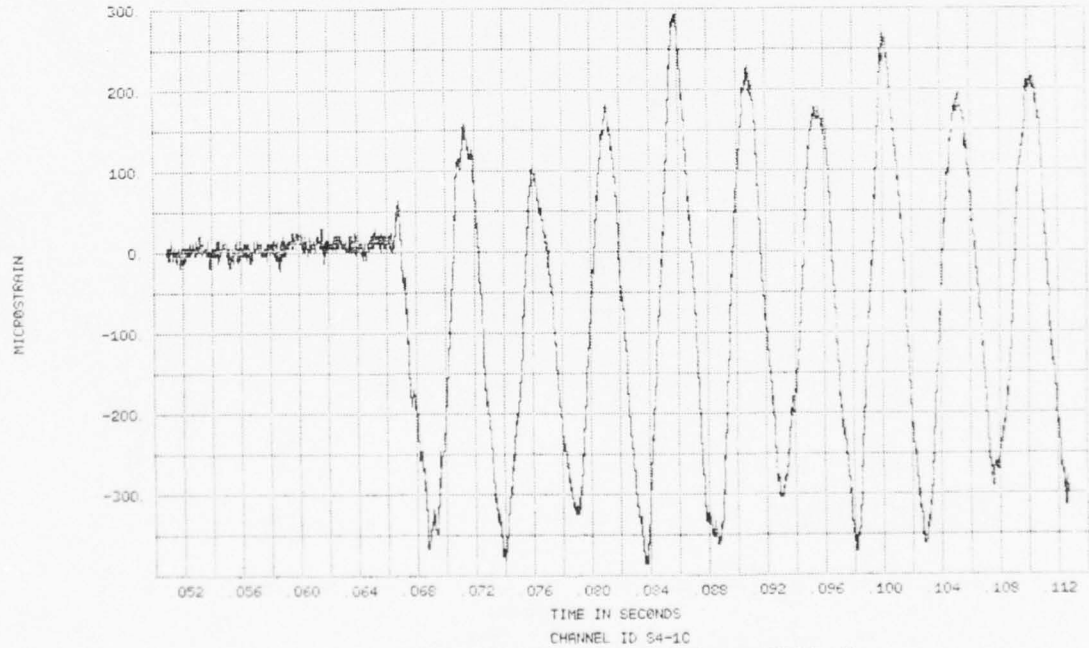


FIGURE 4-81 , SPECIMEN NO. 4 , SHOT NO. 6 ,
STRAIN TIME HISTORY

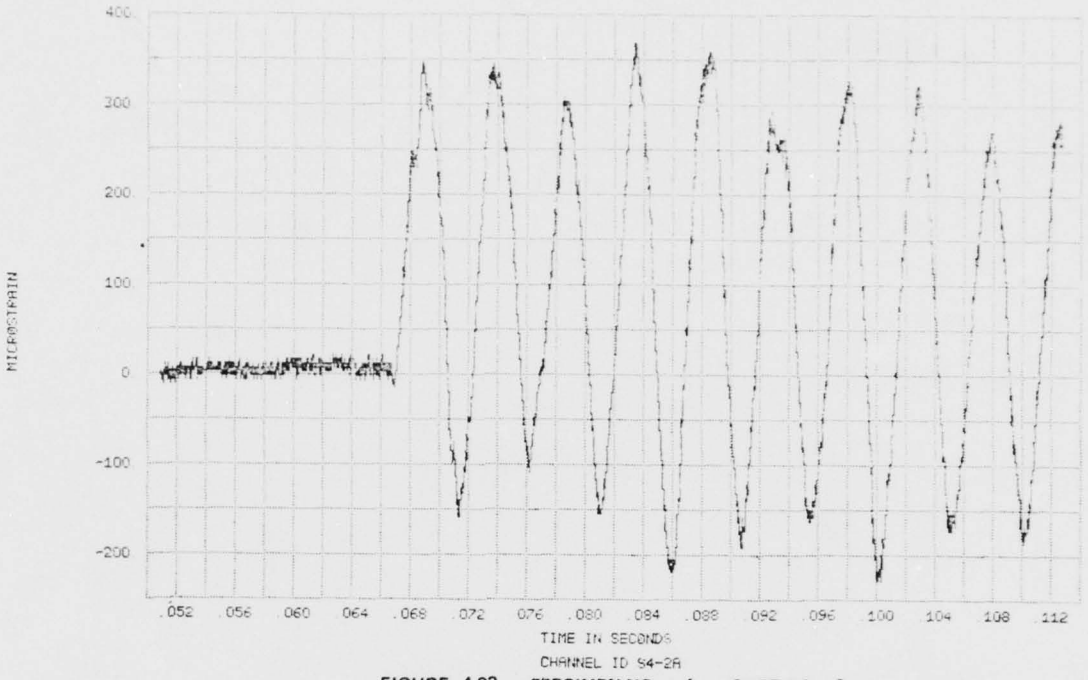


FIGURE 4-82 , SPECIMEN NO. 4 , SHOT NO. 6 ,
STRAIN TIME HISTORY

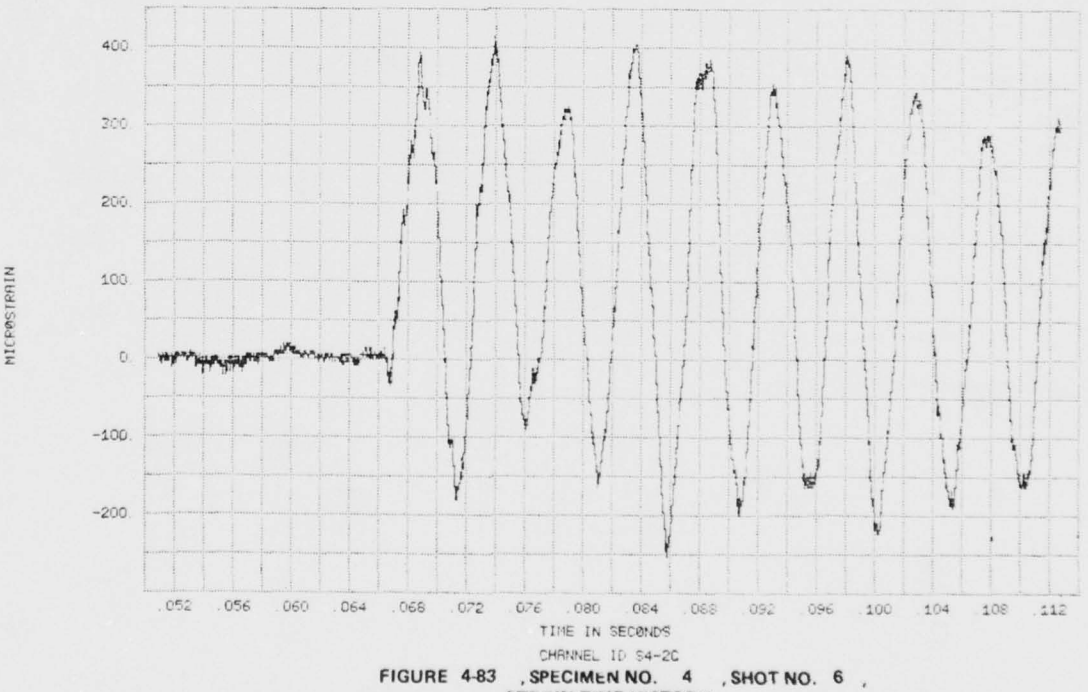


FIGURE 4-83 , SPECIMEN NO. 4 , SHOT NO. 6 ,
STRAIN TIME HISTORY

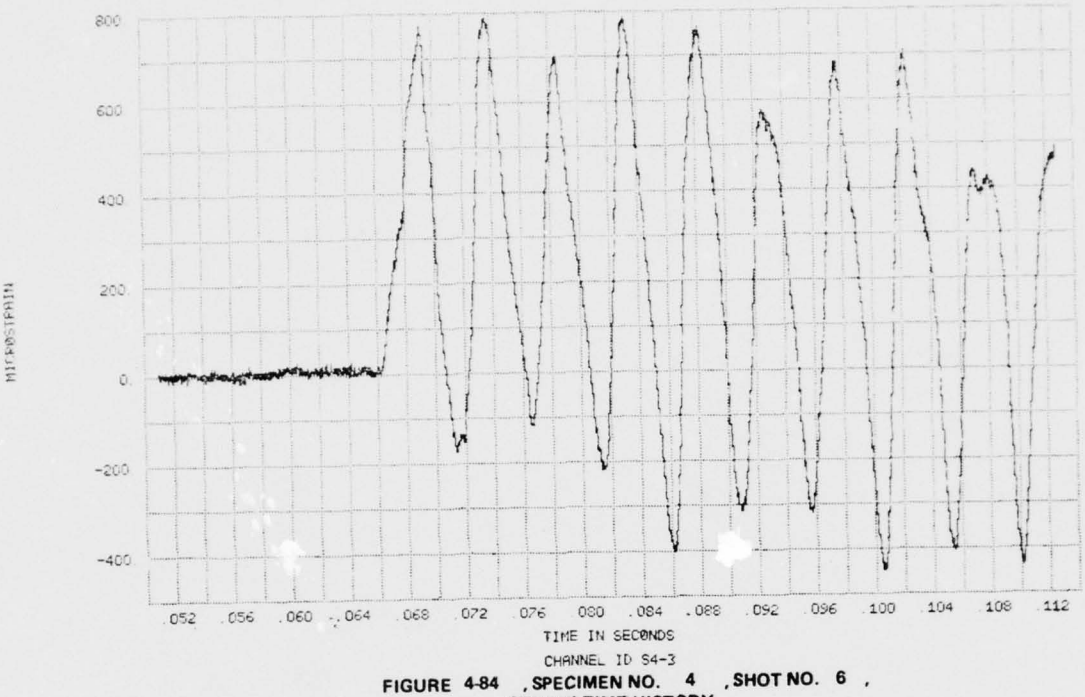


FIGURE 4-84 , SPECIMEN NO. 4 , SHOT NO. 6 , STRAIN TIME HISTORY

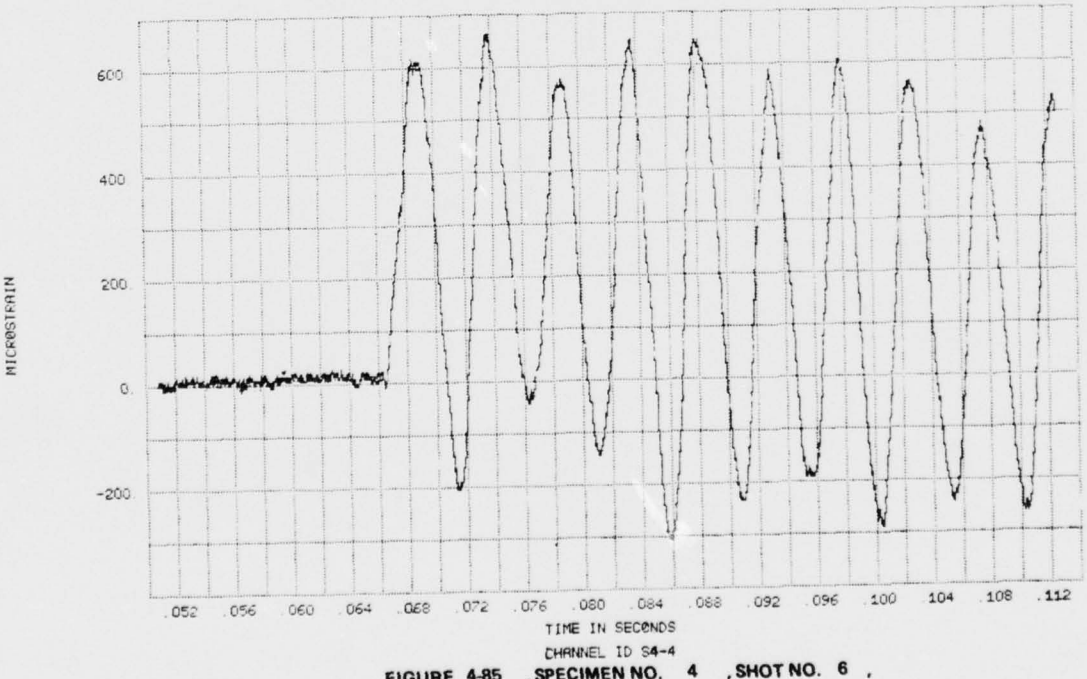


FIGURE 4-85 , SPECIMEN NO. 4 , SHOT NO. 6 , STRAIN TIME HISTORY

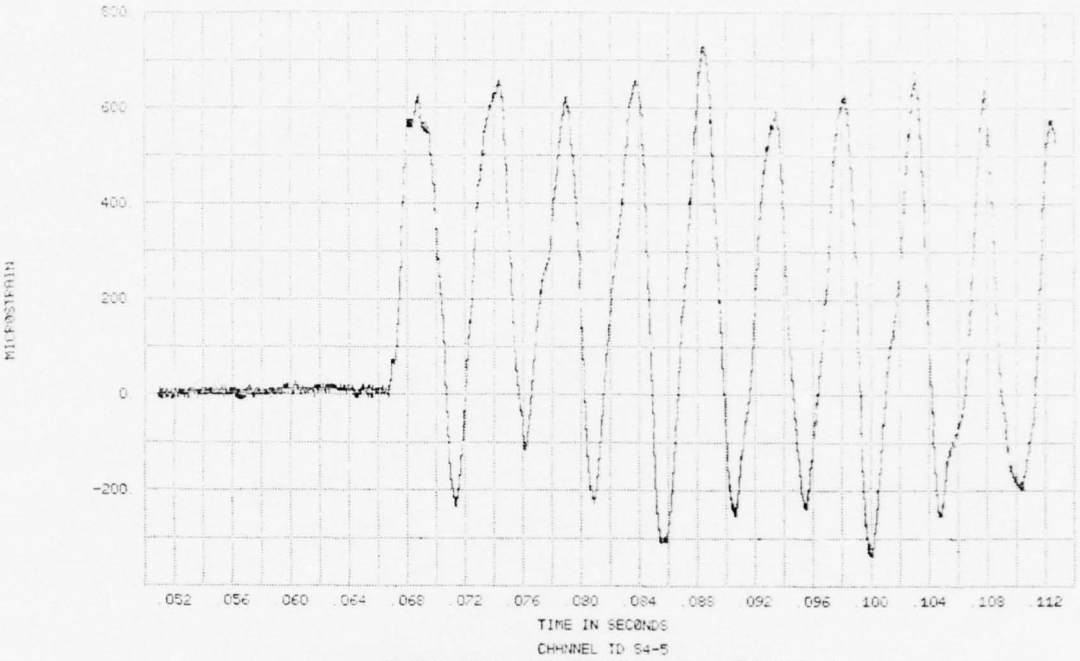


FIGURE 4-86 , SPECIMEN NO. 4 , SHOT NO. 6 ,
STRAIN TIME HISTORY

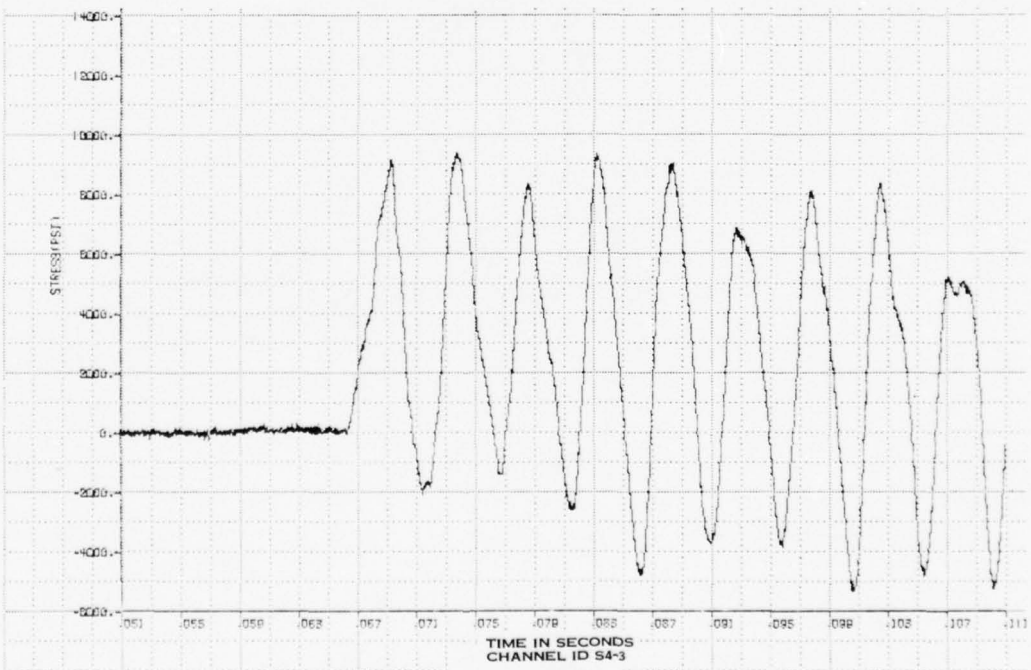


FIGURE 4-87 , SPECIMEN NO. 4 , SHOT NO. 6 ,
STRESS TIME HISTORY

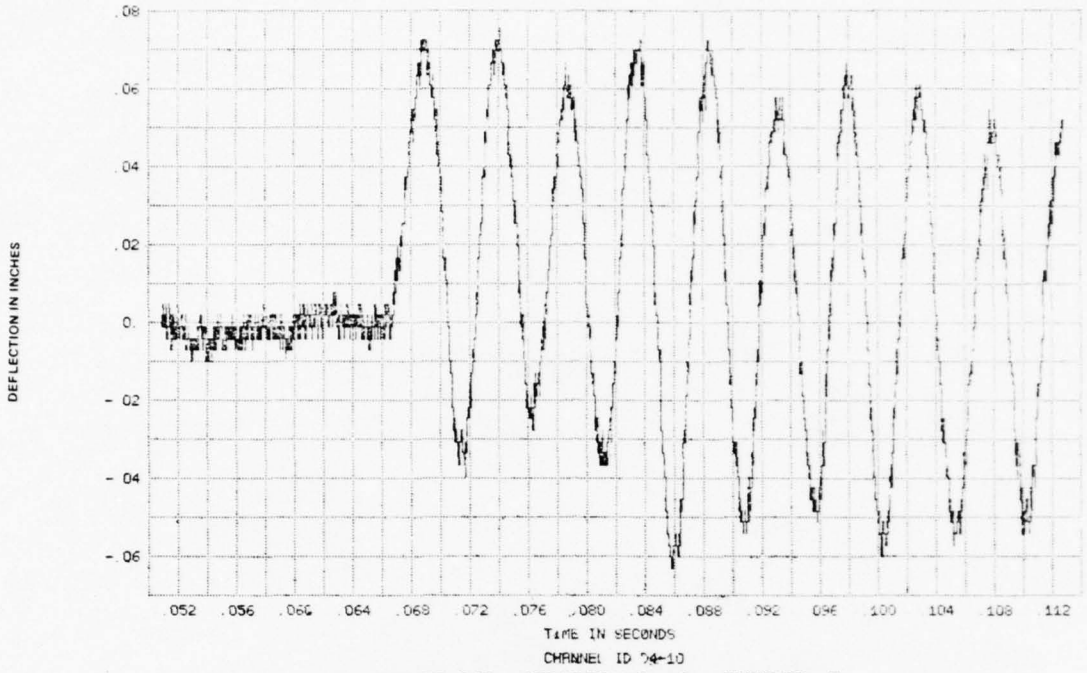


FIGURE 4-88 , SPECIMEN NO. 4 , SHOT NO. 6 ,
DEFLECTION TIME HISTORY

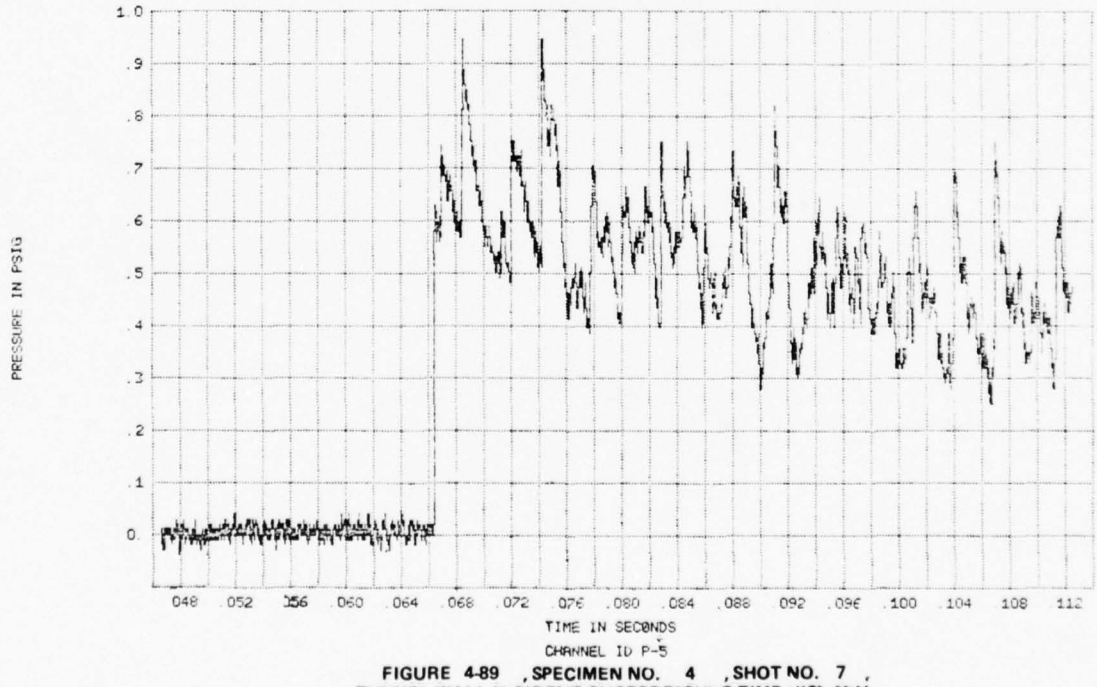


FIGURE 4-89 , SPECIMEN NO. 4 , SHOT NO. 7 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

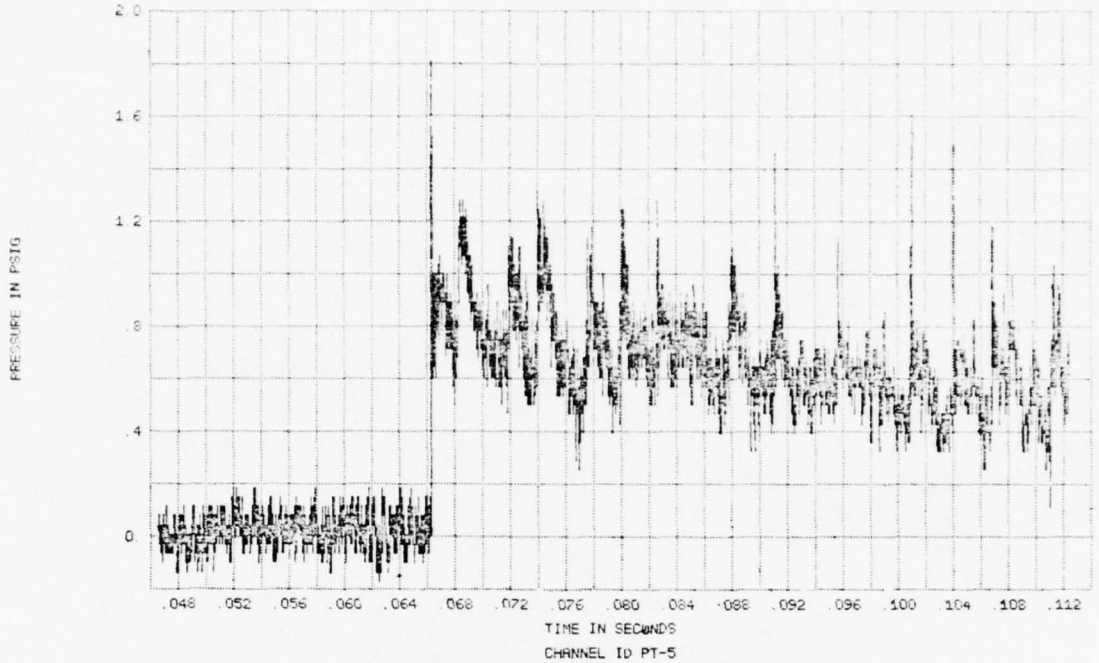


FIGURE 4-90 , SPECIMEN NO. 4 , SHOT NO. 7 .
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

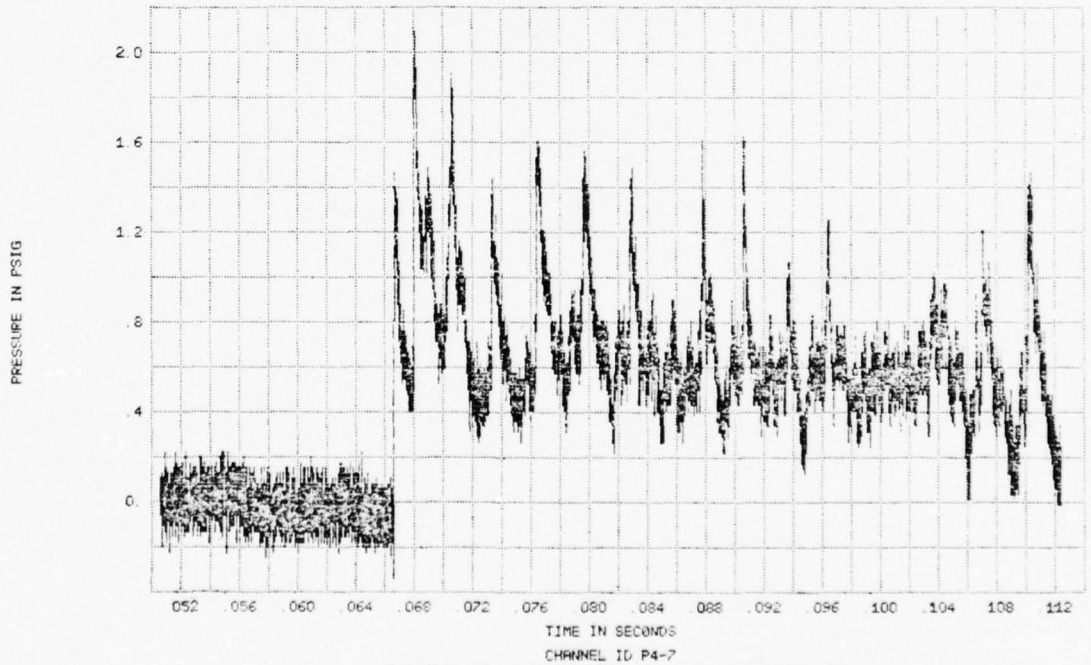


FIGURE 4-91 , SPECIMEN NO. 4 , SHOT NO. 7 .
SPECIMEN REFLECTED PRESSURE TIME HISTORY

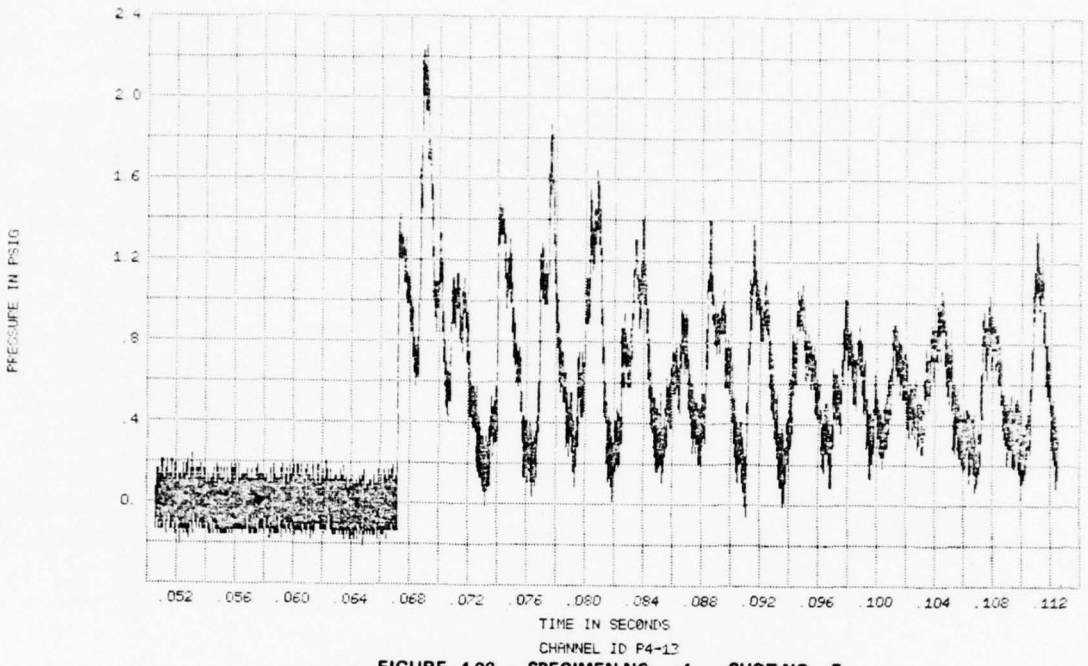


FIGURE 4-92 , SPECIMEN NO. 4 , SHOT NO. 7 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

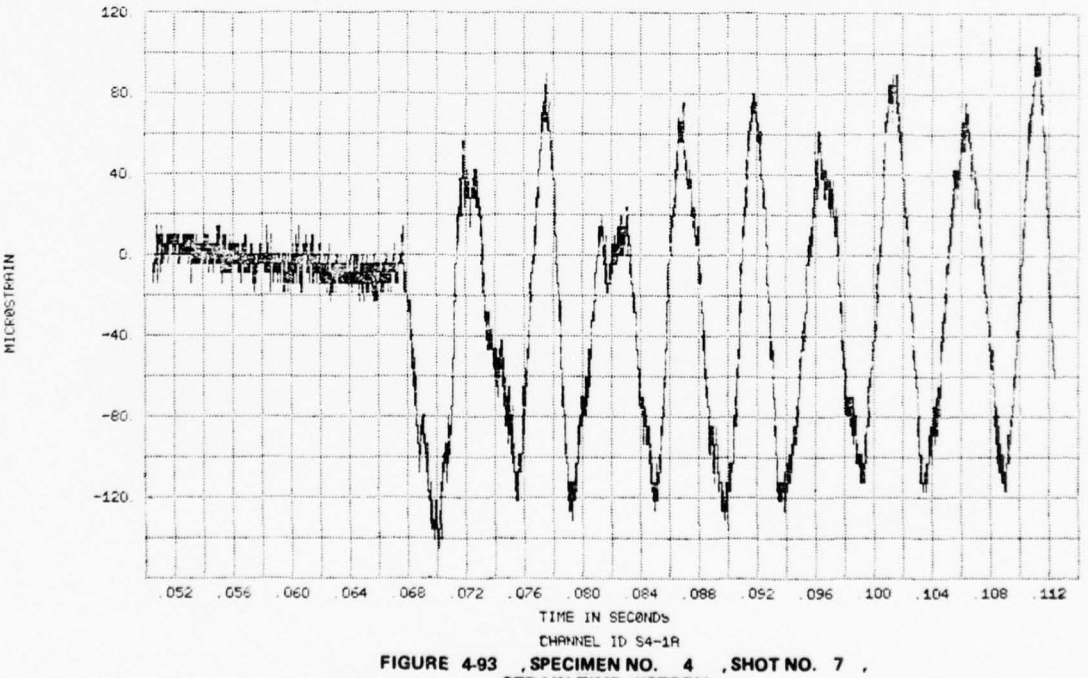


FIGURE 4-93 , SPECIMEN NO. 4 , SHOT NO. 7 ,
STRAIN TIME HISTORY

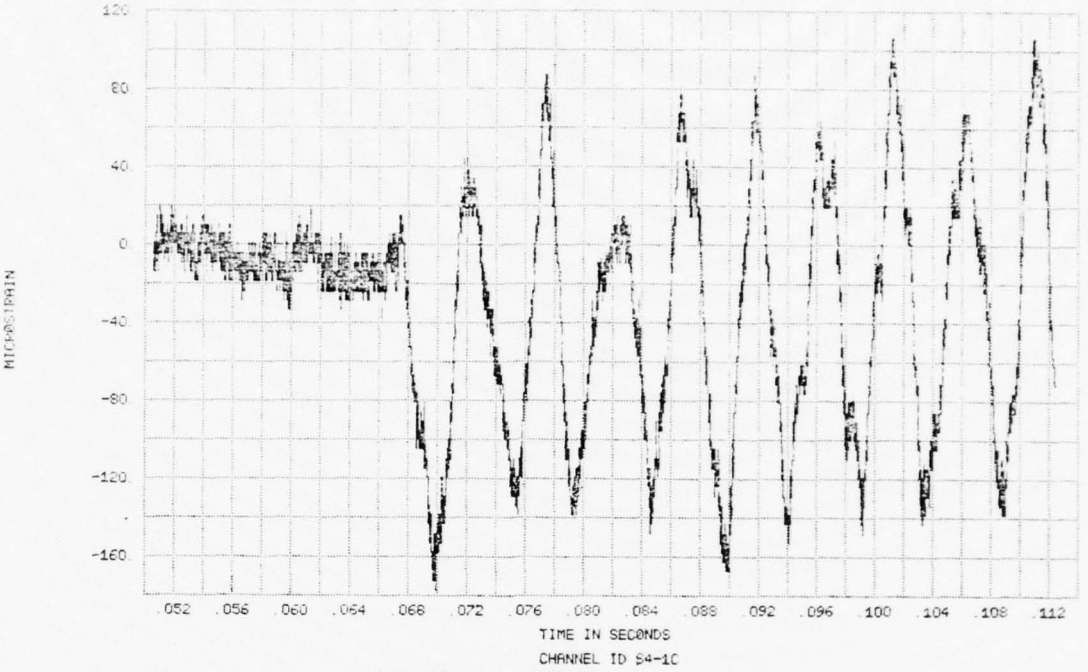


FIGURE 4-94 , SPECIMEN NO. 4 , SHOT NO. 7 , STRAIN TIME HISTORY

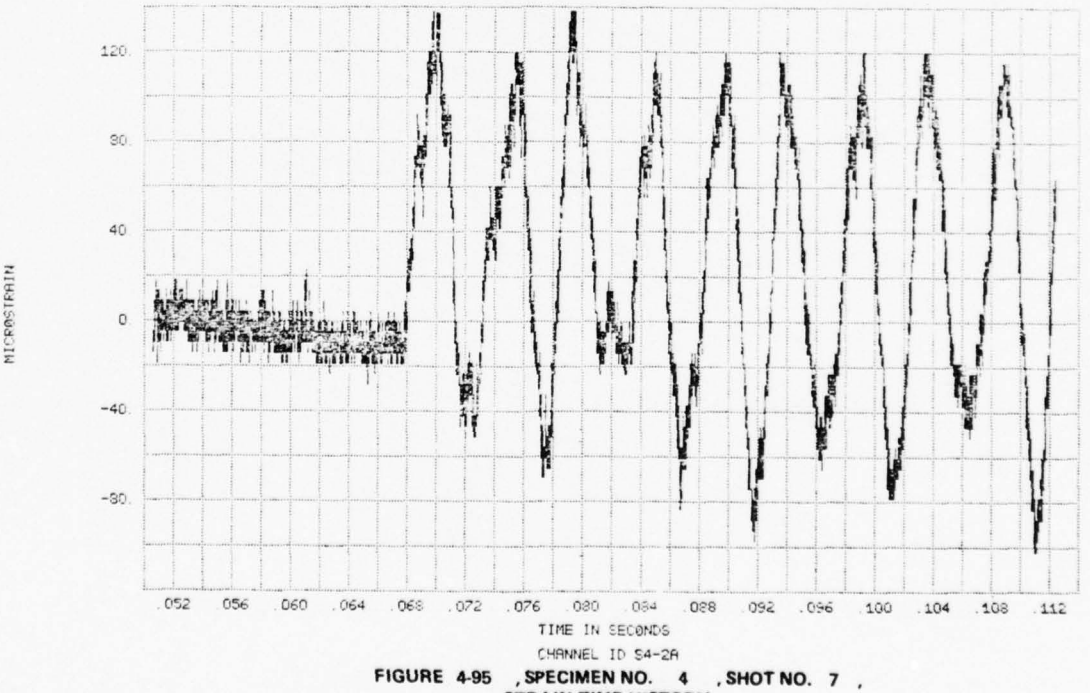


FIGURE 4-95 , SPECIMEN NO. 4 , SHOT NO. 7 , STRAIN TIME HISTORY

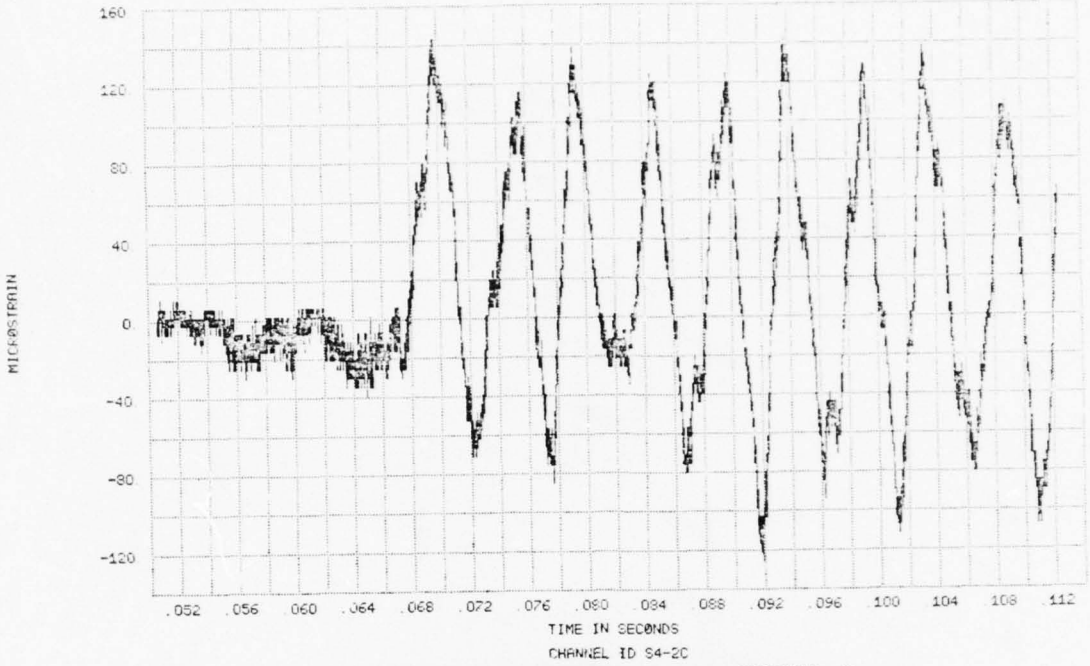


FIGURE 4-96 , SPECIMEN NO. 4 , SHOT NO. 7 ,
STRAIN TIME HISTORY

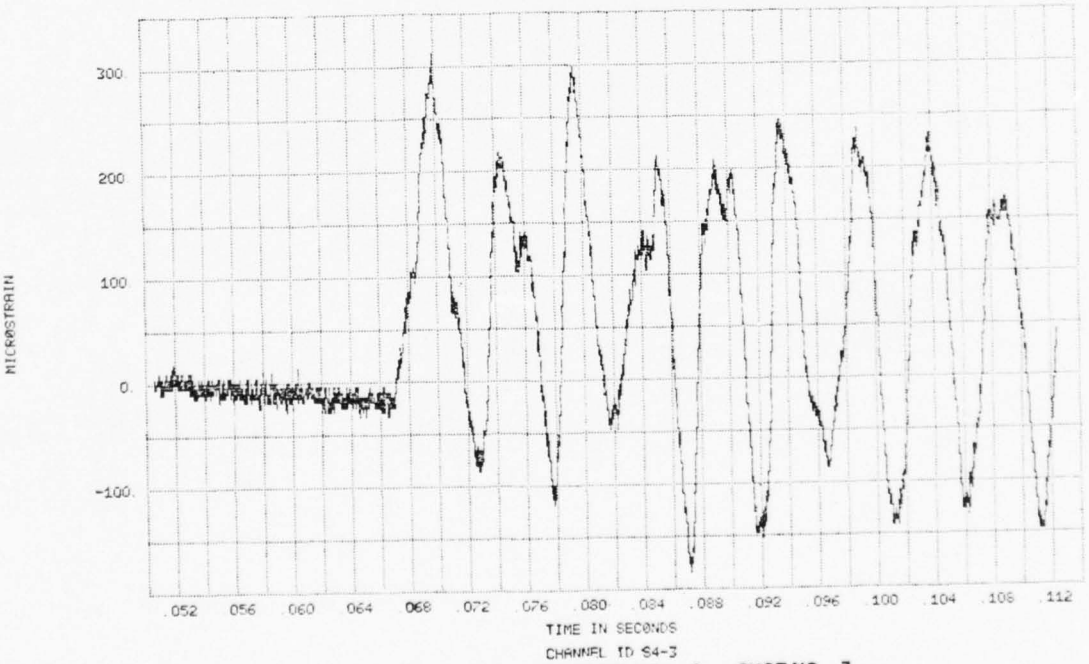


FIGURE 4-97 , SPECIMEN NO. 4 , SHOT NO. 7 ,
STRAIN TIME HISTORY

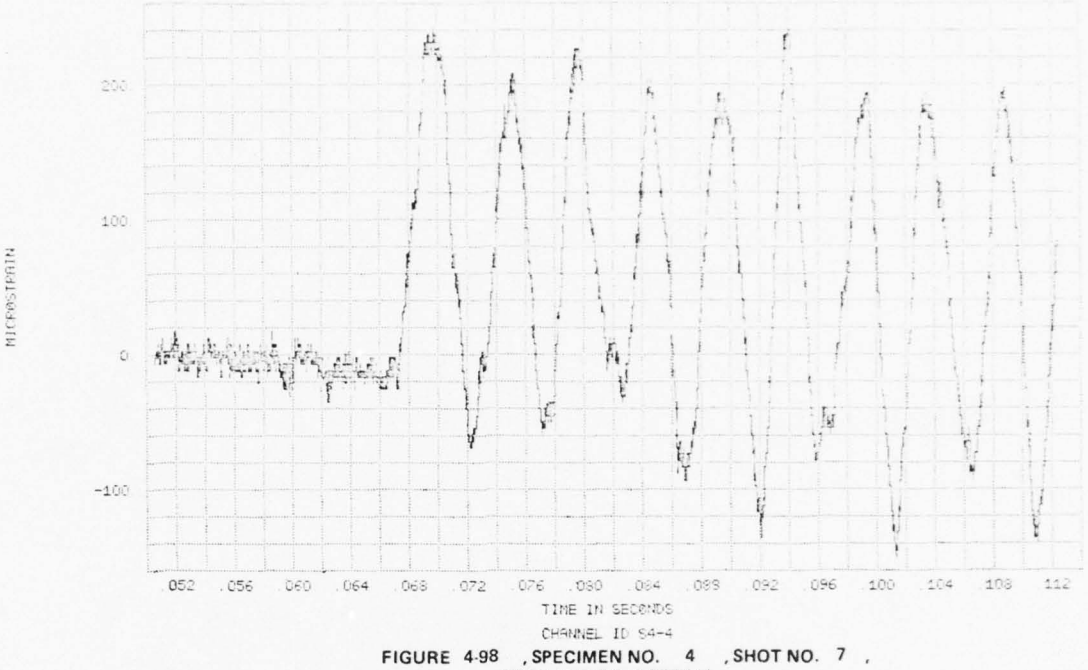


FIGURE 4-98 , SPECIMEN NO. 4 , SHOT NO. 7 ,
STRAIN TIME HISTORY

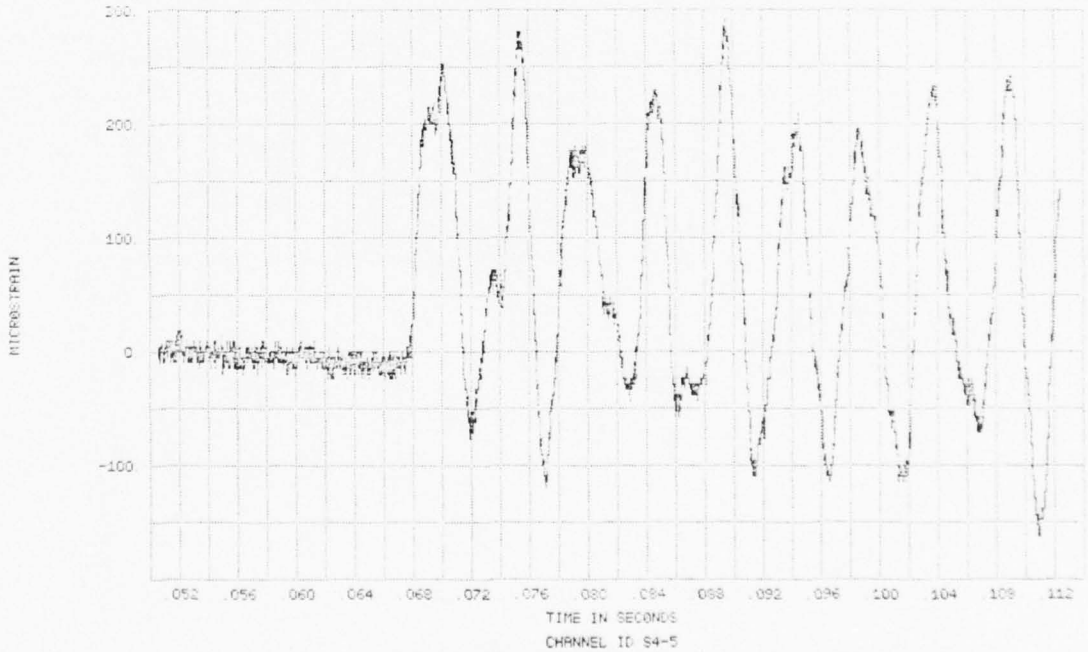


FIGURE 4-99 , SPECIMEN NO. 4 , SHOT NO. 7 ,
STRAIN TIME HISTORY

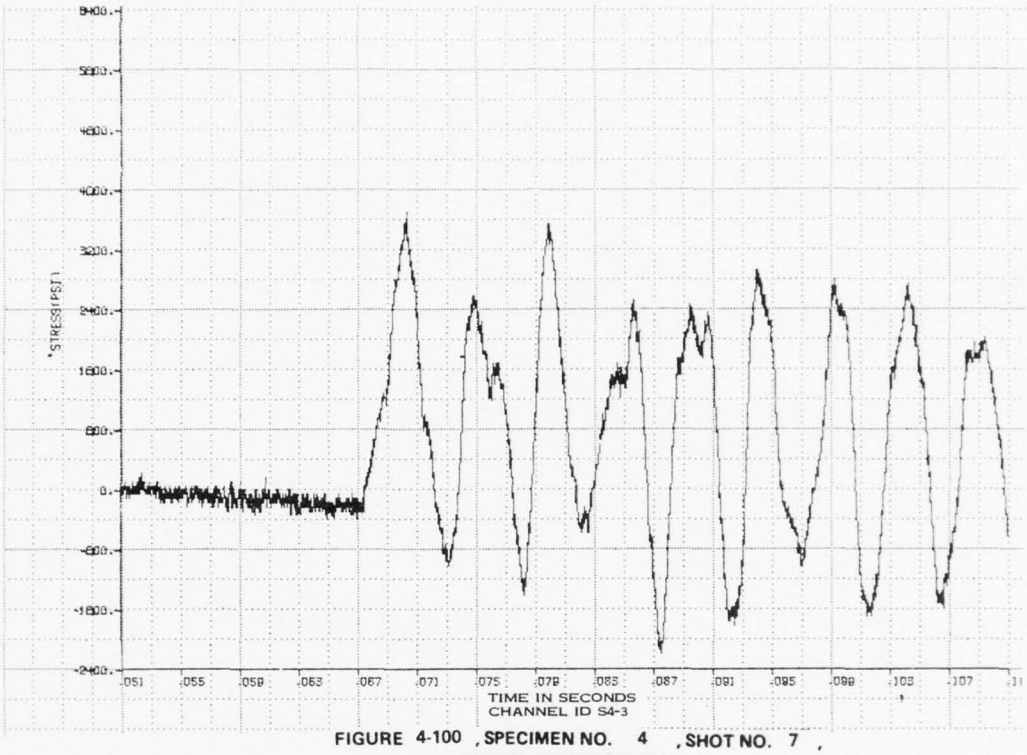


FIGURE 4-100 , SPECIMEN NO. 4 , SHOT NO. 7 ,
STRESS TIME HISTORY

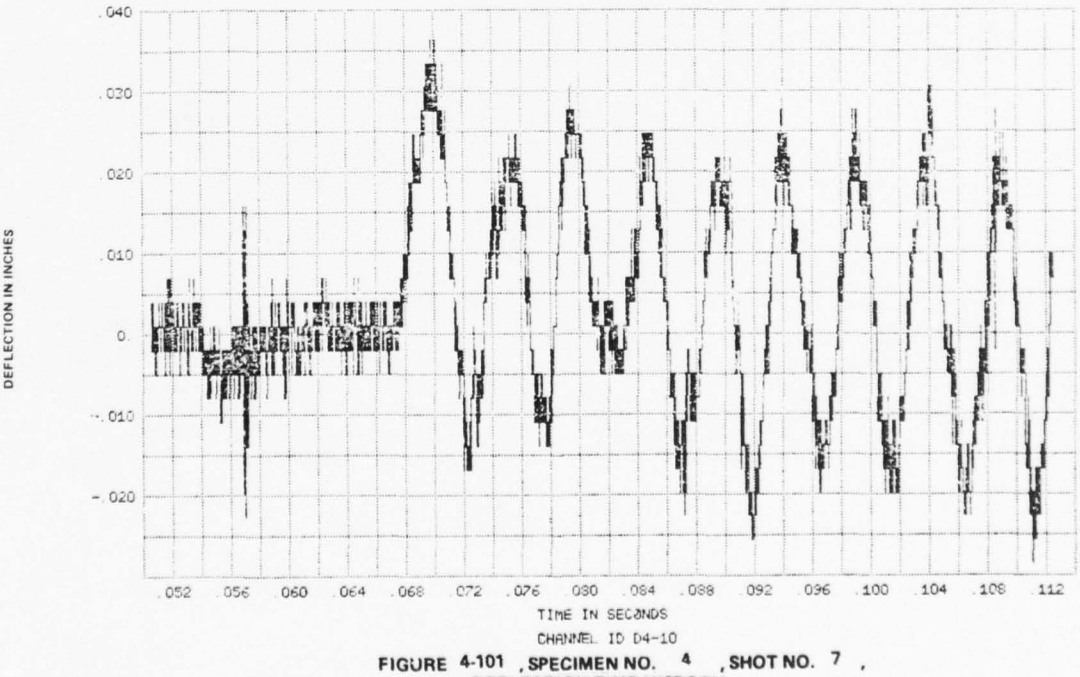


FIGURE 4-101 , SPECIMEN NO. 4 , SHOT NO. 7 ,
DEFLECTION TIME HISTORY

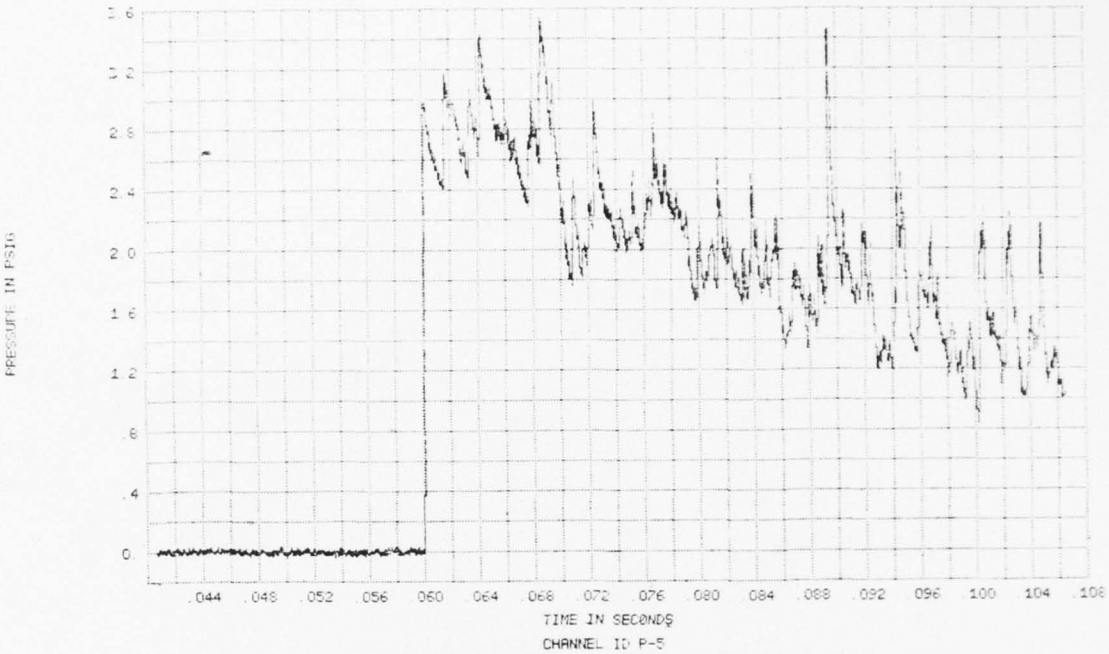


FIGURE 4-102 , SPECIMEN NO. 4 , SHOT NO. 8 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

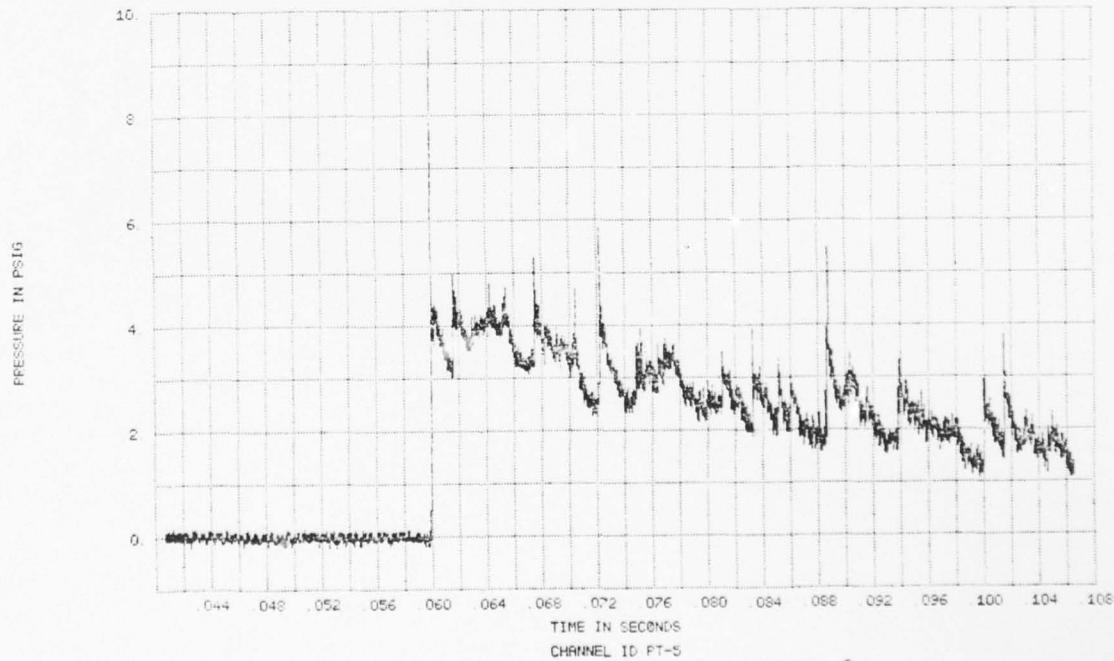


FIGURE 4-103 , SPECIMEN NO. 4 , SHOT NO. 8 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

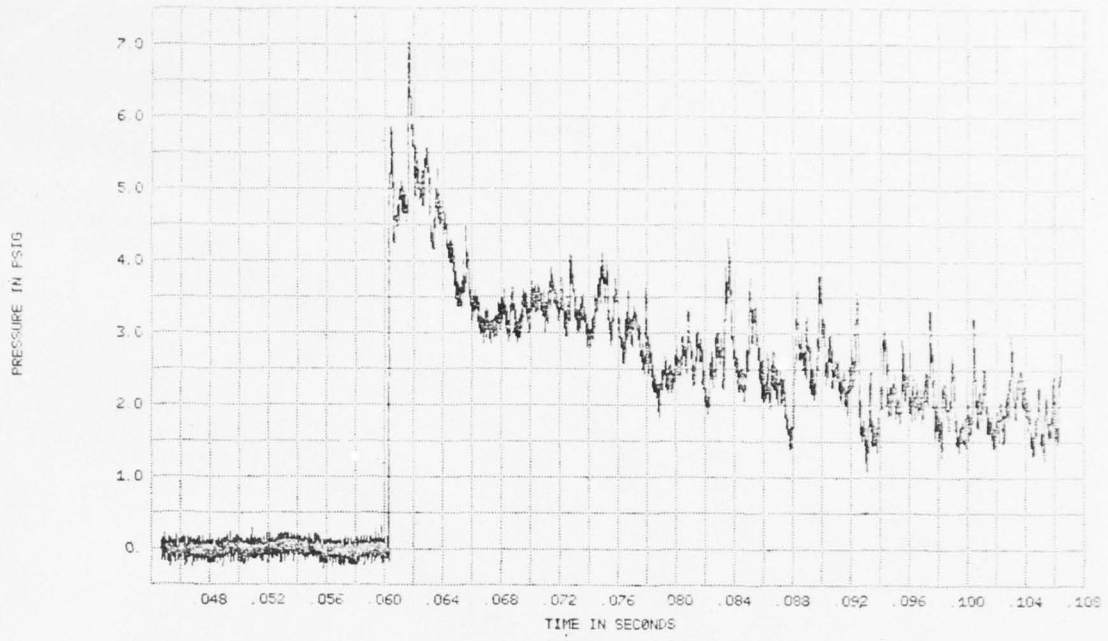


FIGURE 4-104 , SPECIMEN NO. 4 , SHOT NO. 8 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

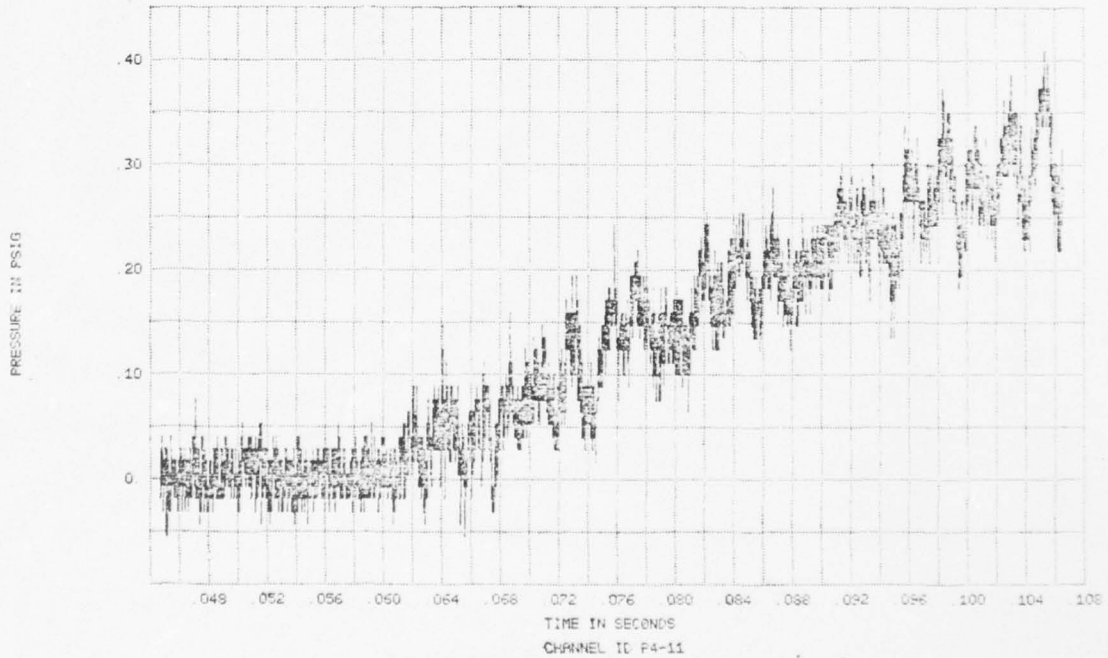


FIGURE 4-105 , SPECIMEN NO. 4 , SHOT NO. 8 ,
INTERNAL PRESSURE TIME HISTORY

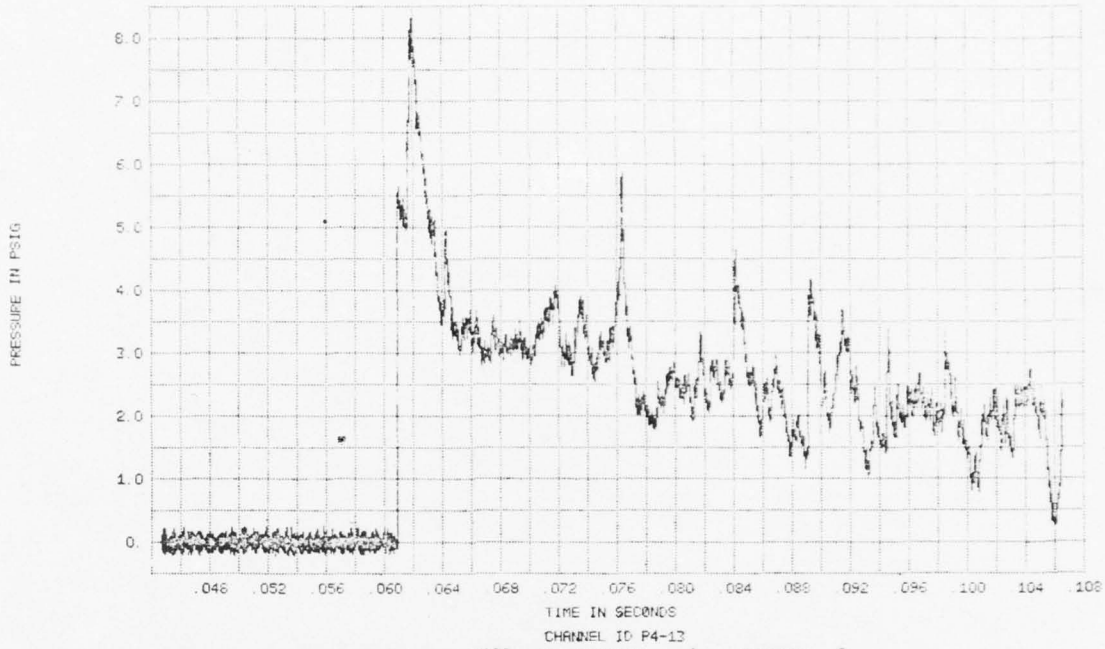


FIGURE 4-106 , SPECIMEN NO. 4 , SHOT NO. 8 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

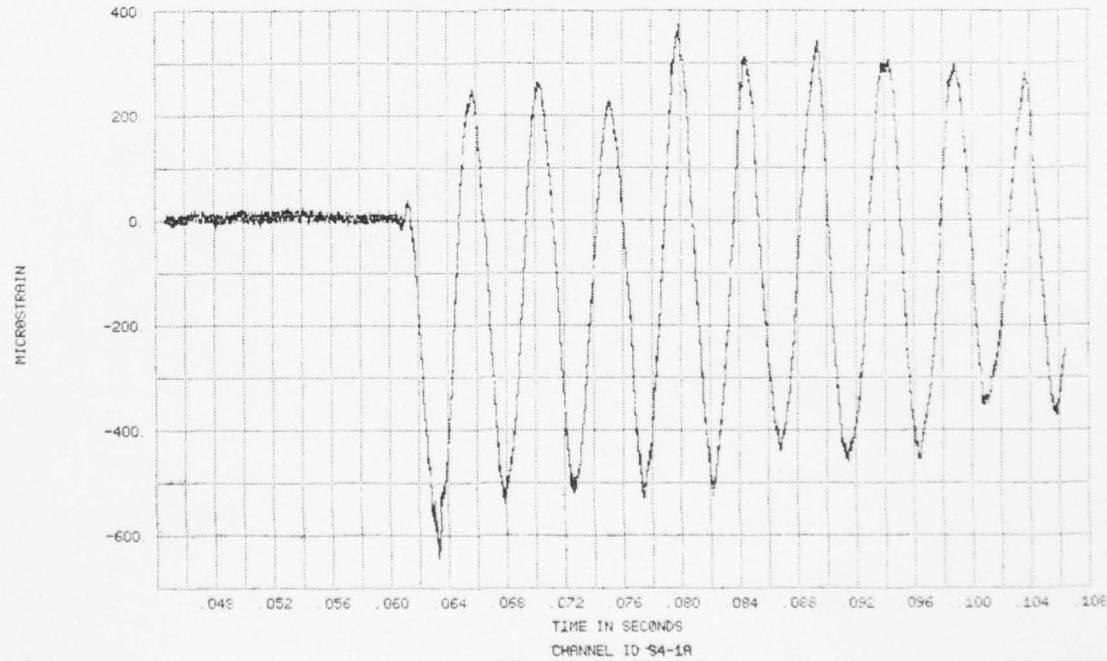


FIGURE 4-107 , SPECIMEN NO. 4 , SHOT NO. 8 ,
STRAIN TIME HISTORY

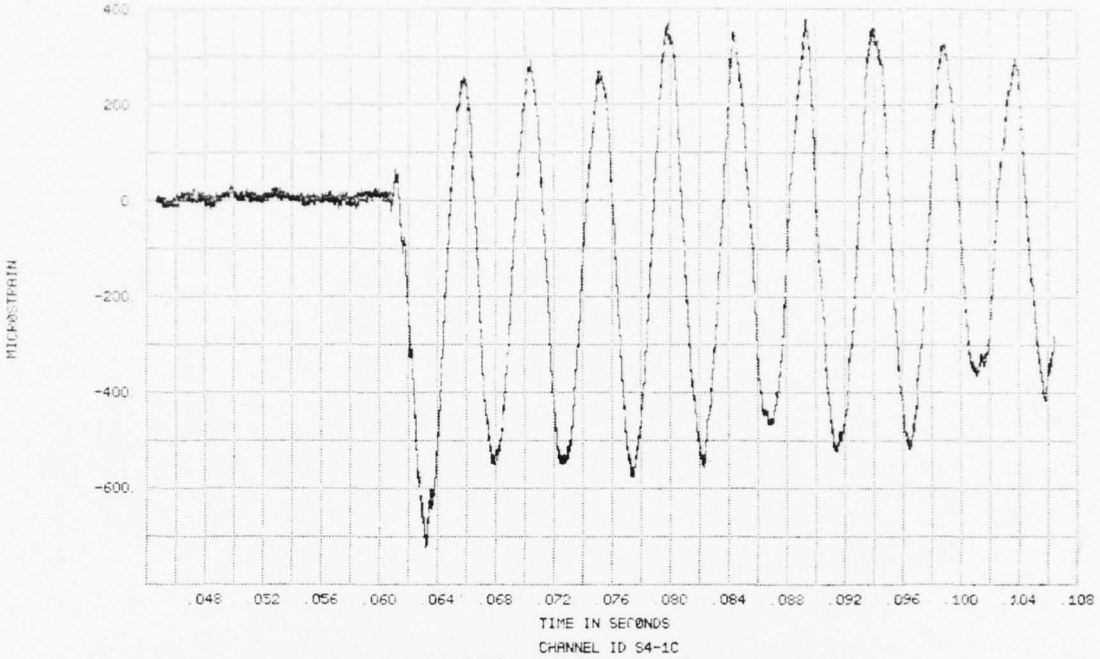


FIGURE 4-108 , SPECIMEN NO. 4 , SHOT NO. 8 ,
STRAIN TIME HISTORY

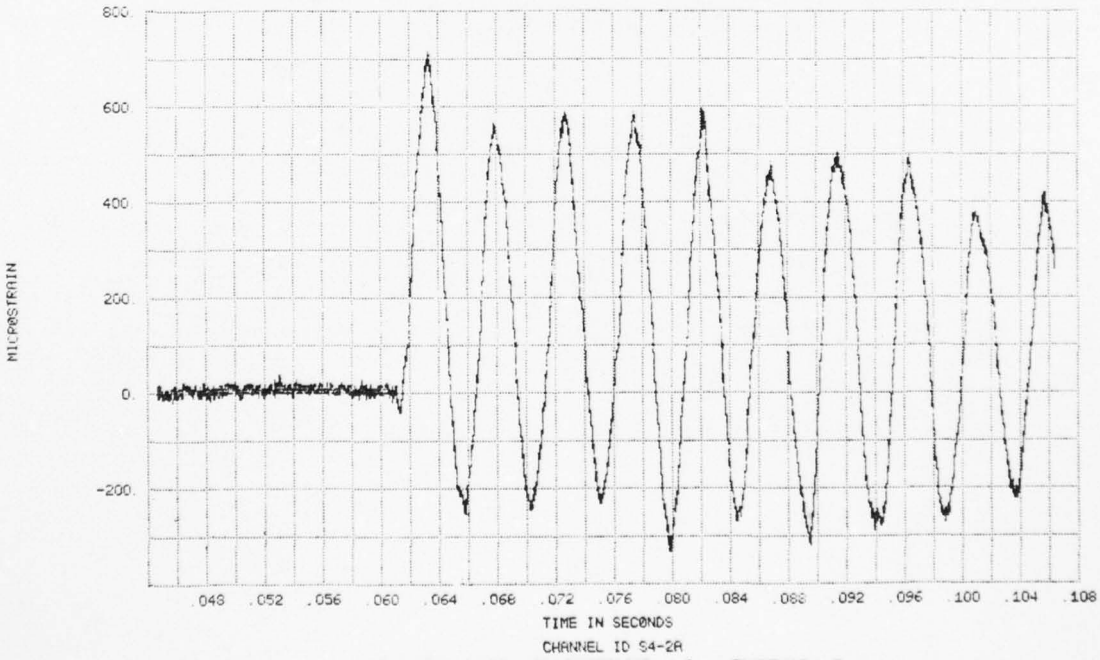


FIGURE 4-109 , SPECIMEN NO. 4 , SHOT NO. 8 ,
STRAIN TIME HISTORY

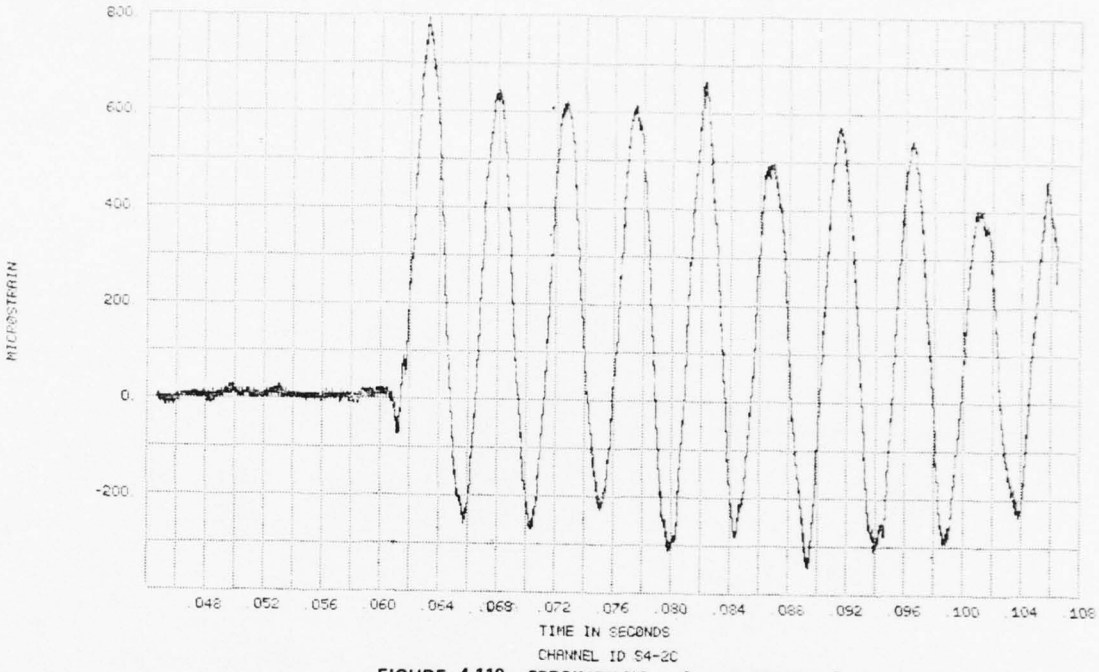


FIGURE 4-110 , SPECIMEN NO. 4 , SHOT NO. 8 ,
STRAIN TIME HISTORY

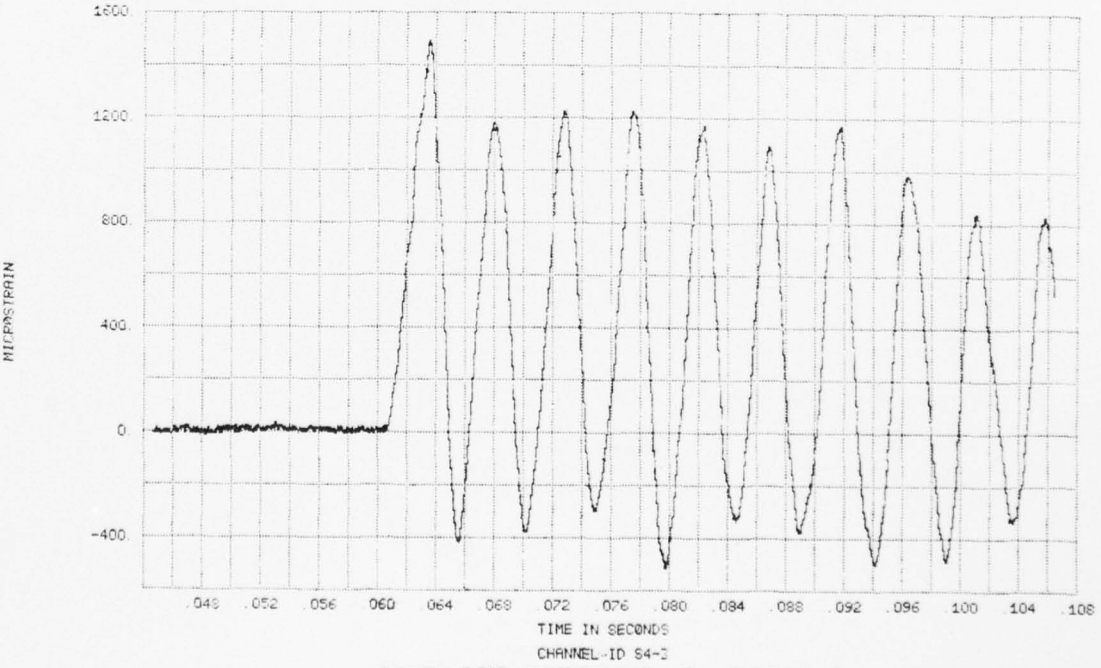


FIGURE 4-111 , SPECIMEN NO. 4 , SHOT NO. 8 ,
STRAIN TIME HISTORY

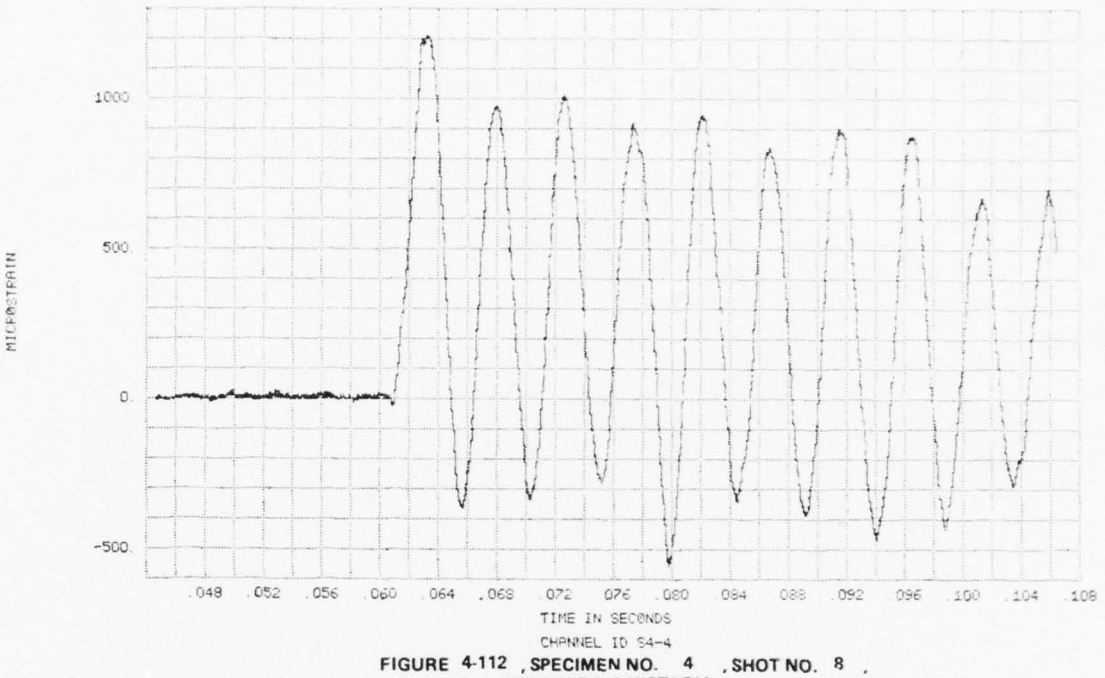


FIGURE 4-112 , SPECIMEN NO. 4 , SHOT NO. 8 ,
STRAIN TIME HISTORY

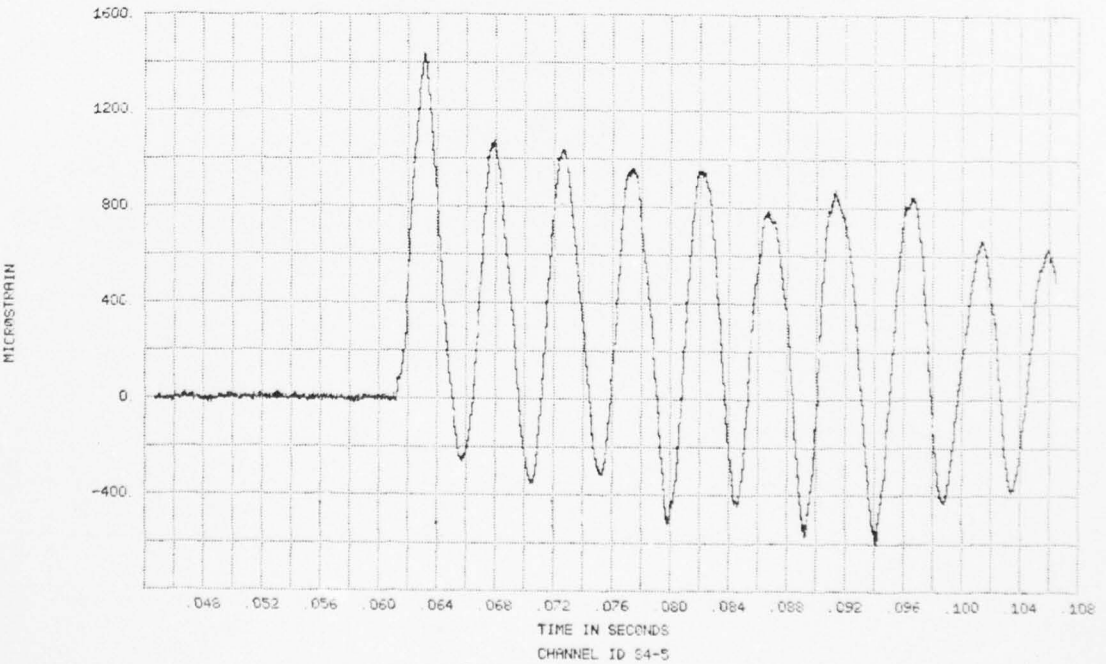


FIGURE 4-113 , SPECIMEN NO. 4 , SHOT NO. 8 ,
STRAIN TIME HISTORY

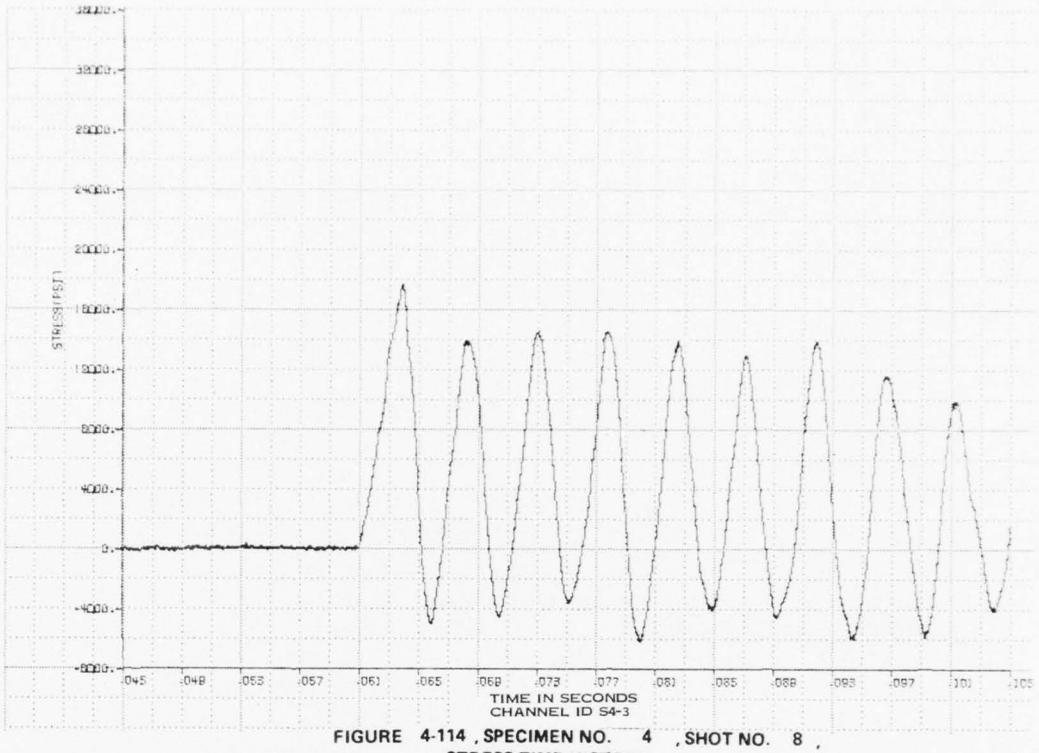


FIGURE 4-114 , SPECIMEN NO. 4 , SHOT NO. 8 ,
STRESS TIME HISTORY

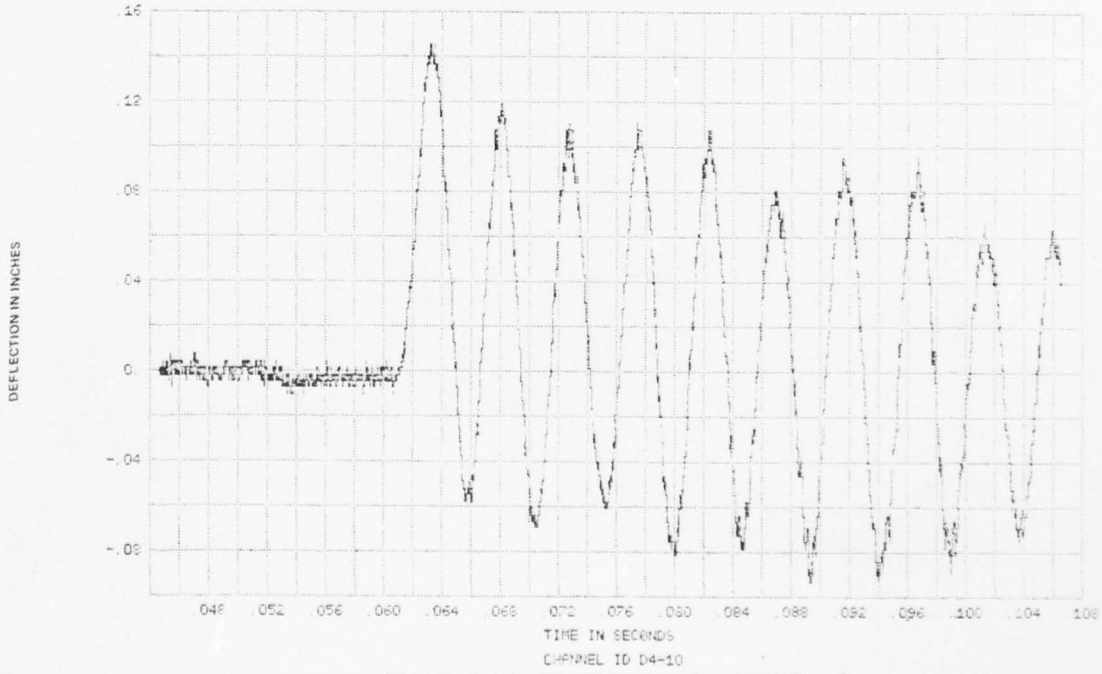


FIGURE 4-115 , SPECIMEN NO. 4 , SHOT NO. 8 ,
DEFLECTION TIME HISTORY

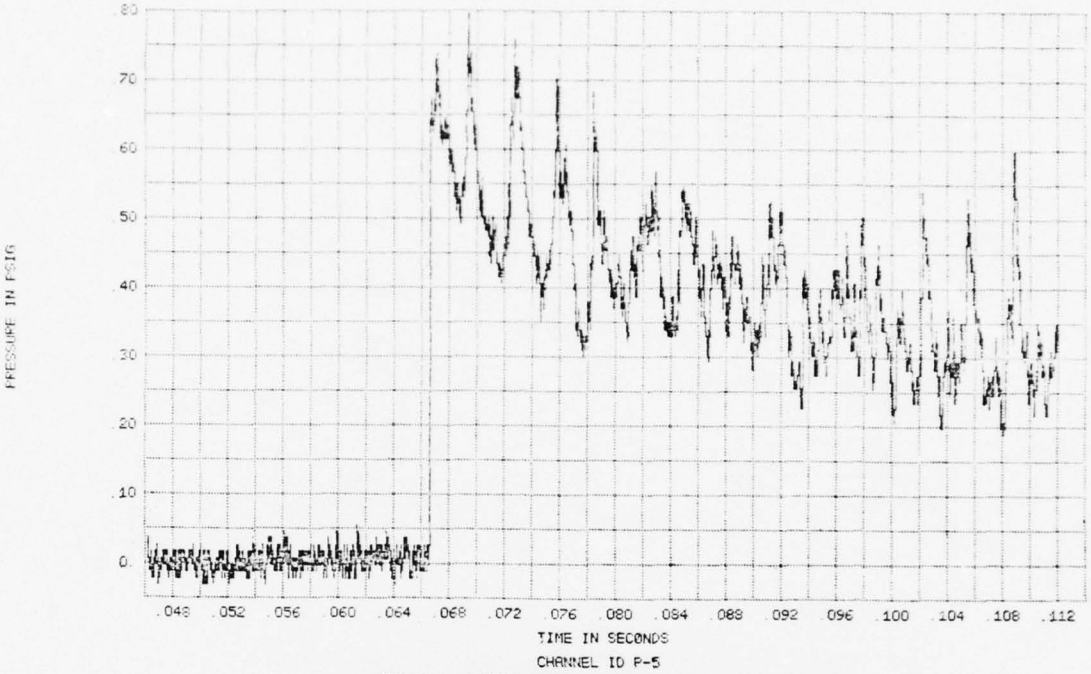


FIGURE 4-116 , SPECIMEN NO. 4 , SHOT NO. 9 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

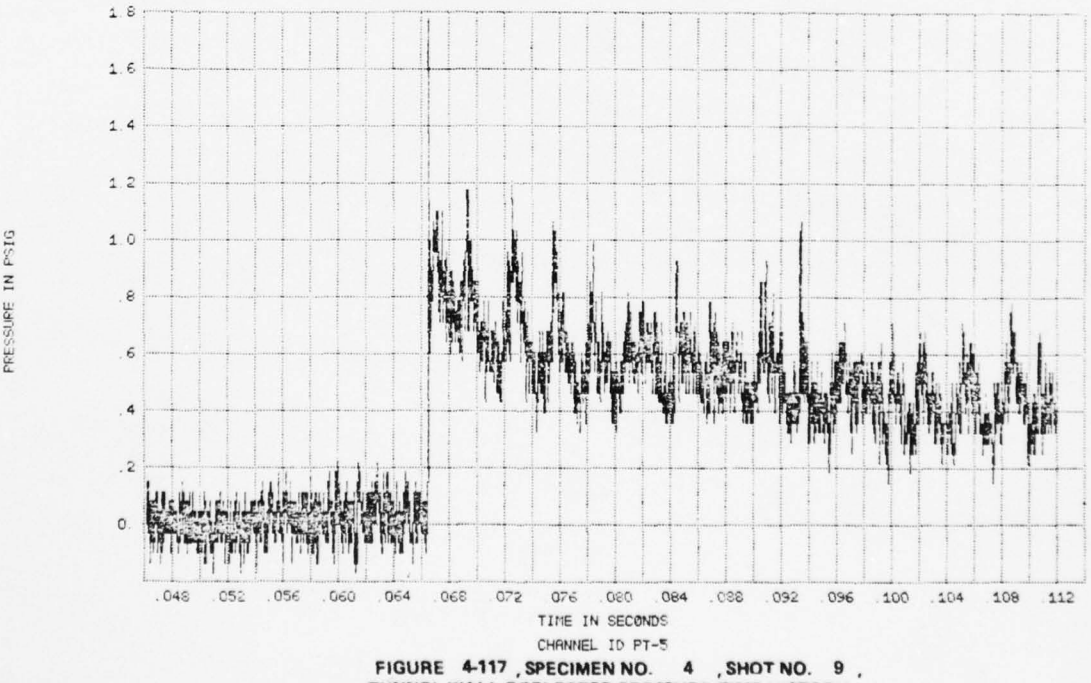


FIGURE 4-117 , SPECIMEN NO. 4 , SHOT NO. 9 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

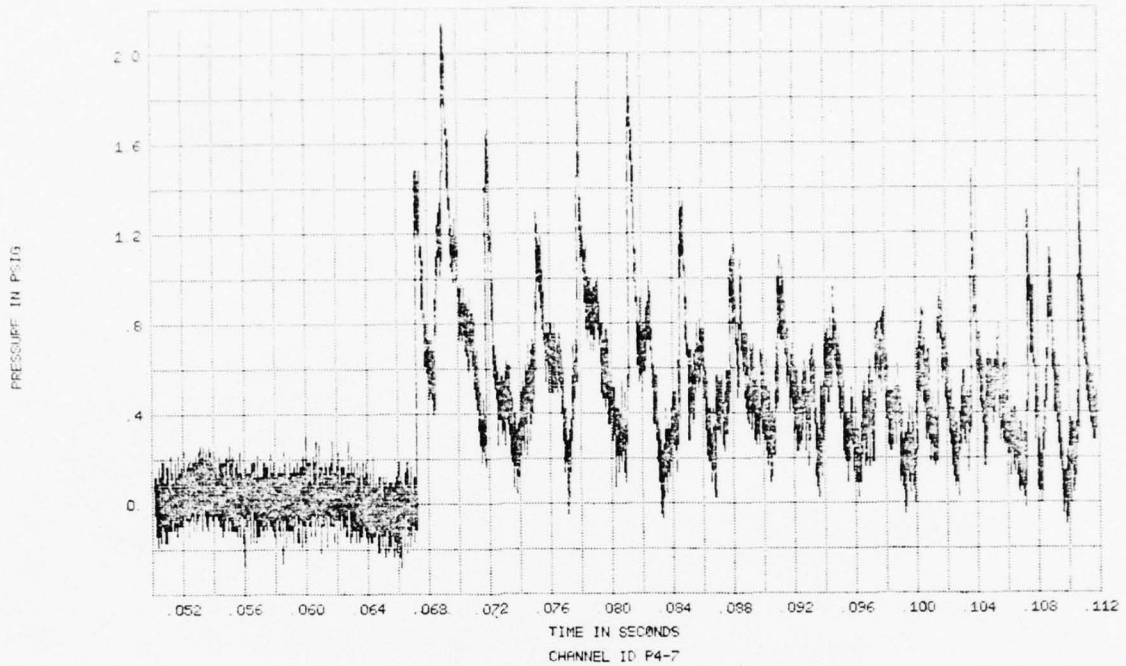


FIGURE 4-118 , SPECIMEN NO. 4 , SHOT NO. 9 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

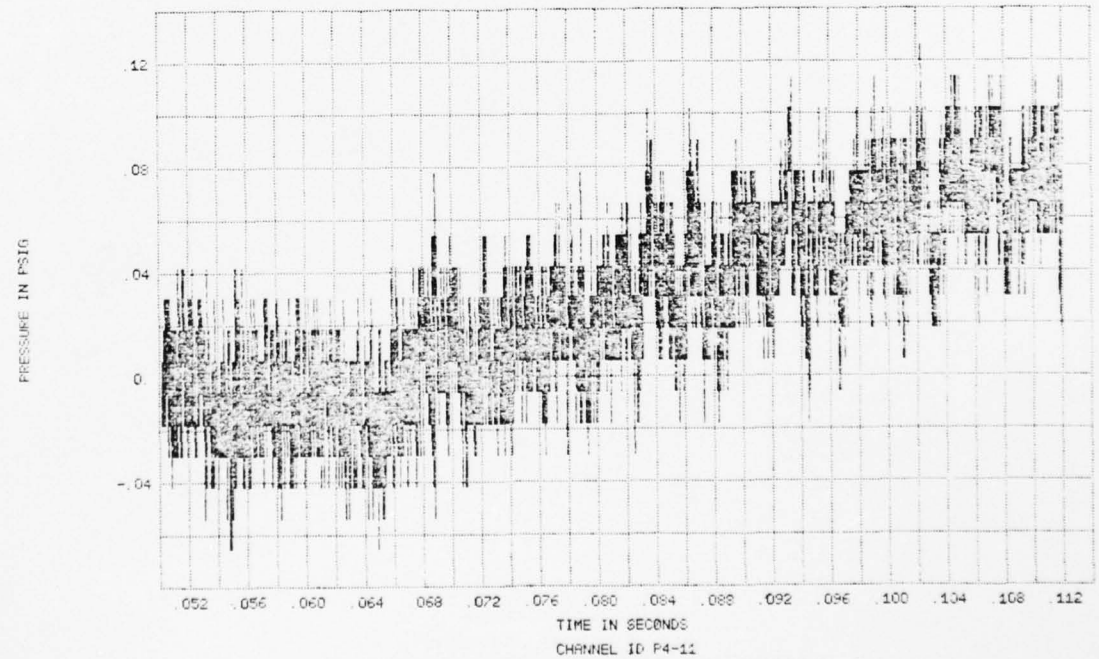


FIGURE 4-119 , SPECIMEN NO. 4 , SHOT NO. 9 ,
INTERNAL PRESSURE TIME HISTORY

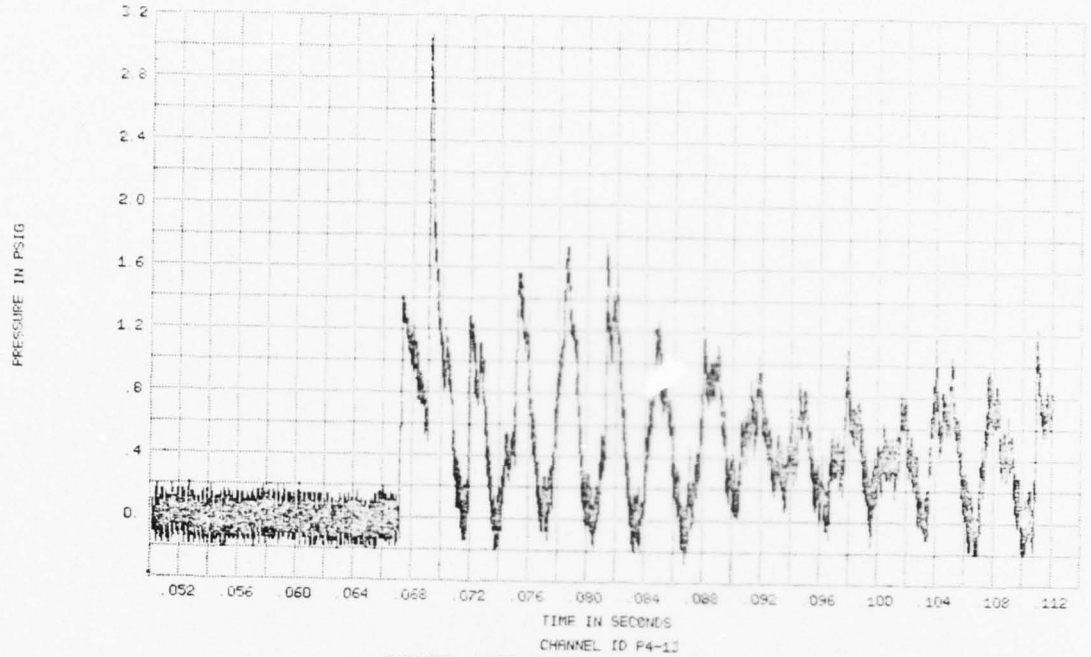


FIGURE 4-120 , SPECIMEN NO. 4 , SHOT NO. 9 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

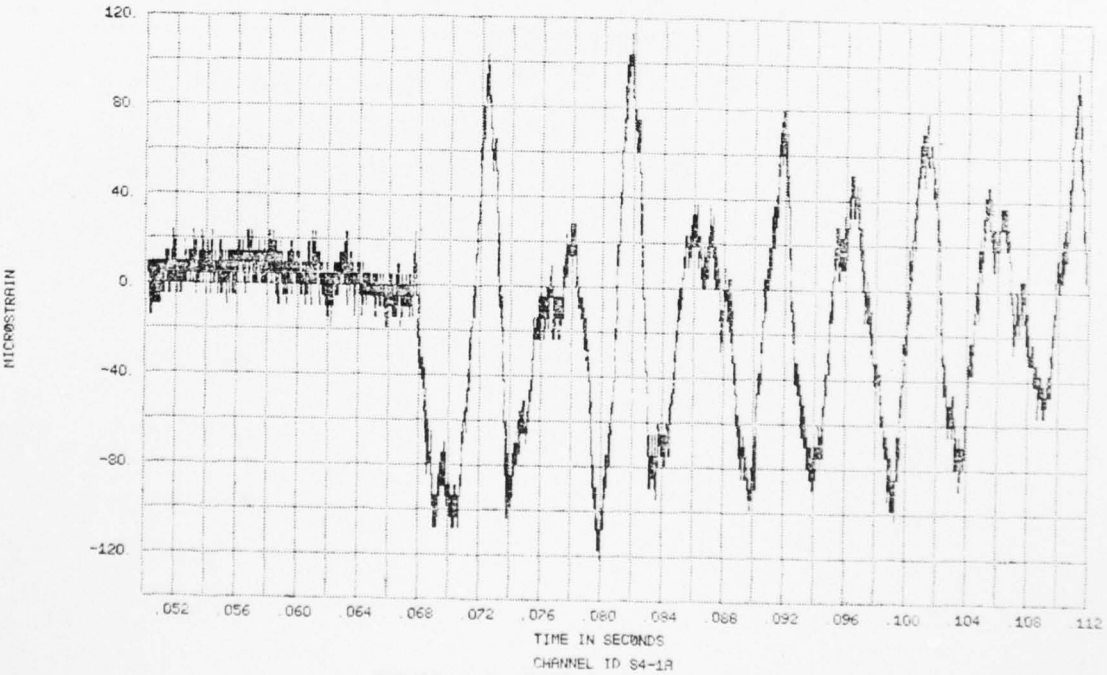


FIGURE 4-121 , SPECIMEN NO. 4 , SHOT NO. 9 ,
STRAIN TIME HISTORY

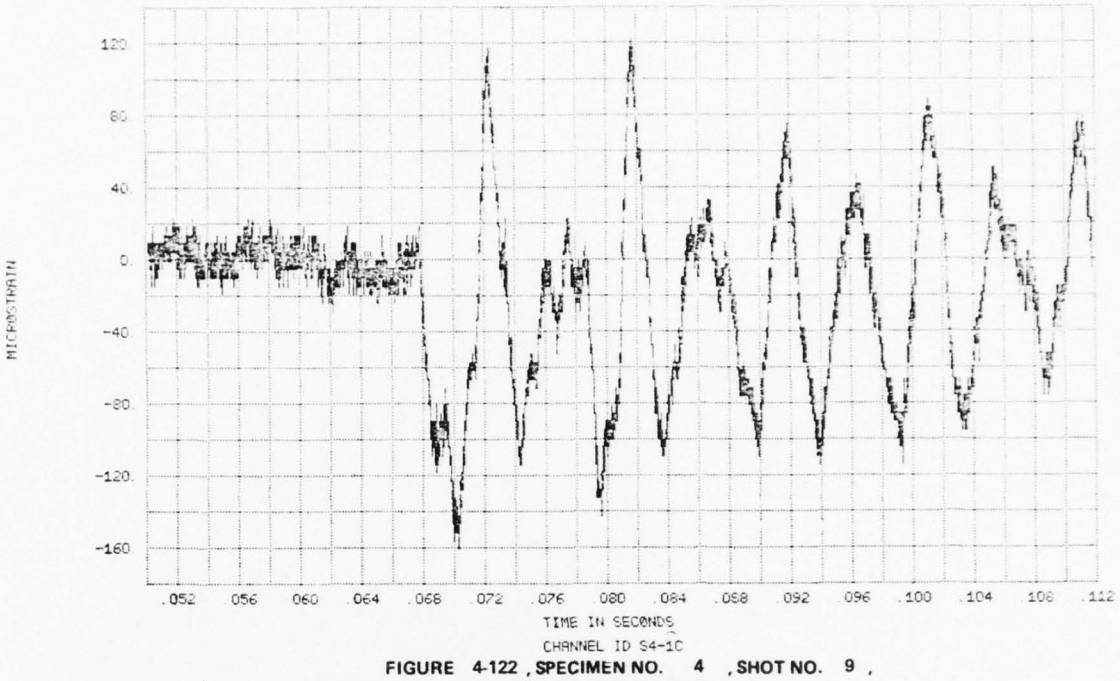


FIGURE 4-122 , SPECIMEN NO. 4 , SHOT NO. 9 , STRAIN TIME HISTORY

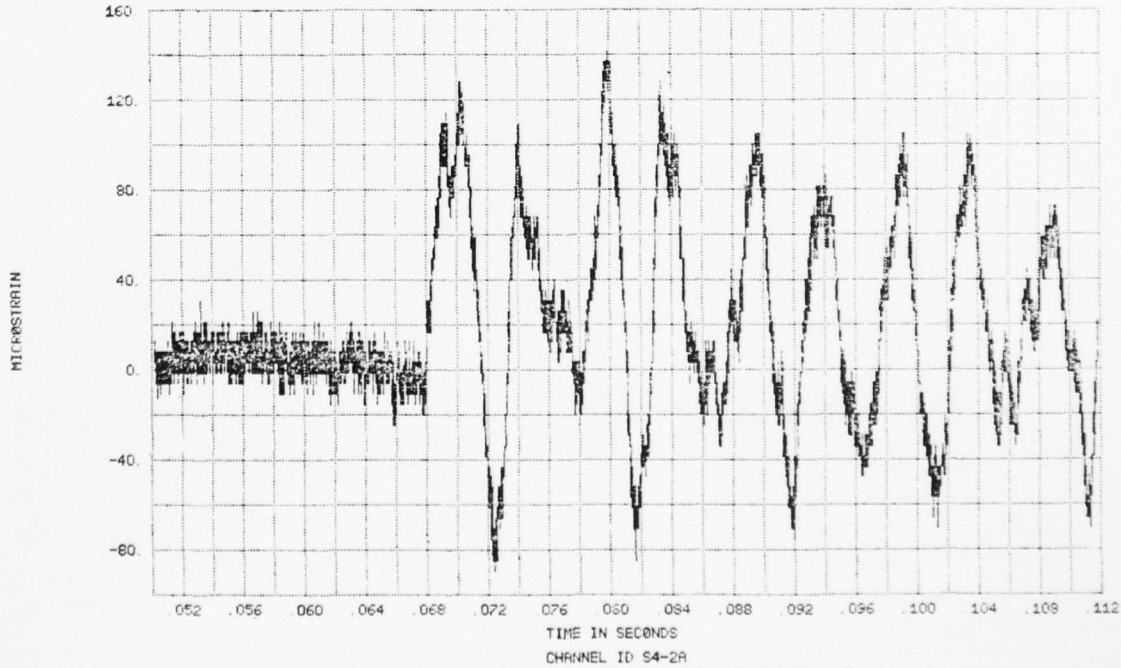


FIGURE 4-123 , SPECIMEN NO. 4 , SHOT NO. 9 , STRAIN TIME HISTORY

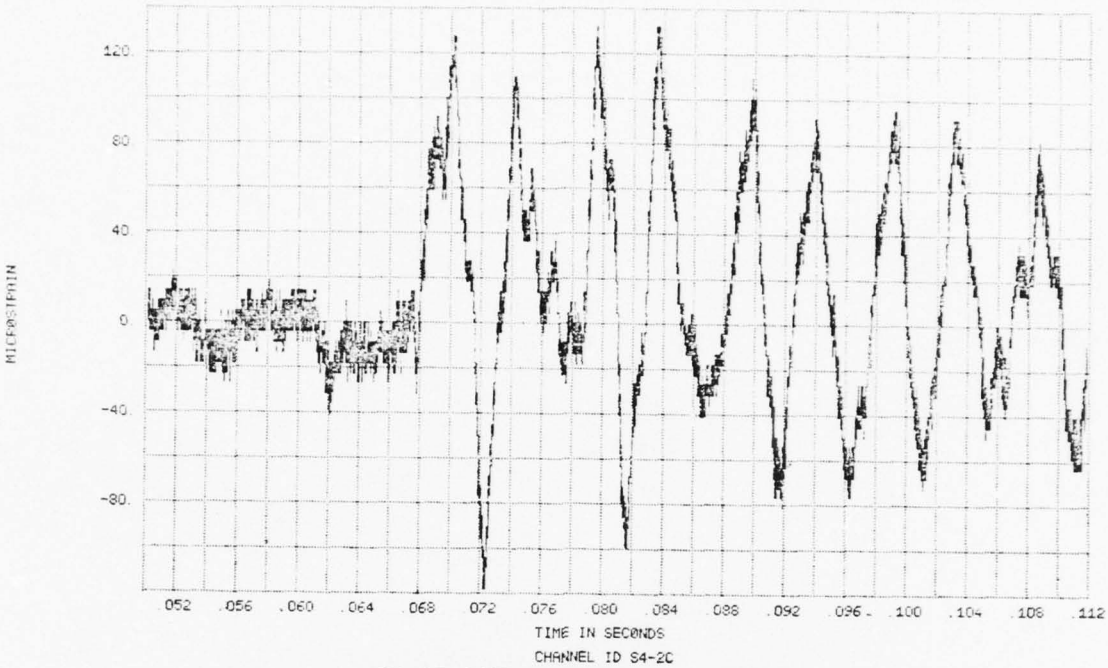


FIGURE 4-124 , SPECIMEN NO. 4 , SHOT NO. 9 , STRAIN TIME HISTORY

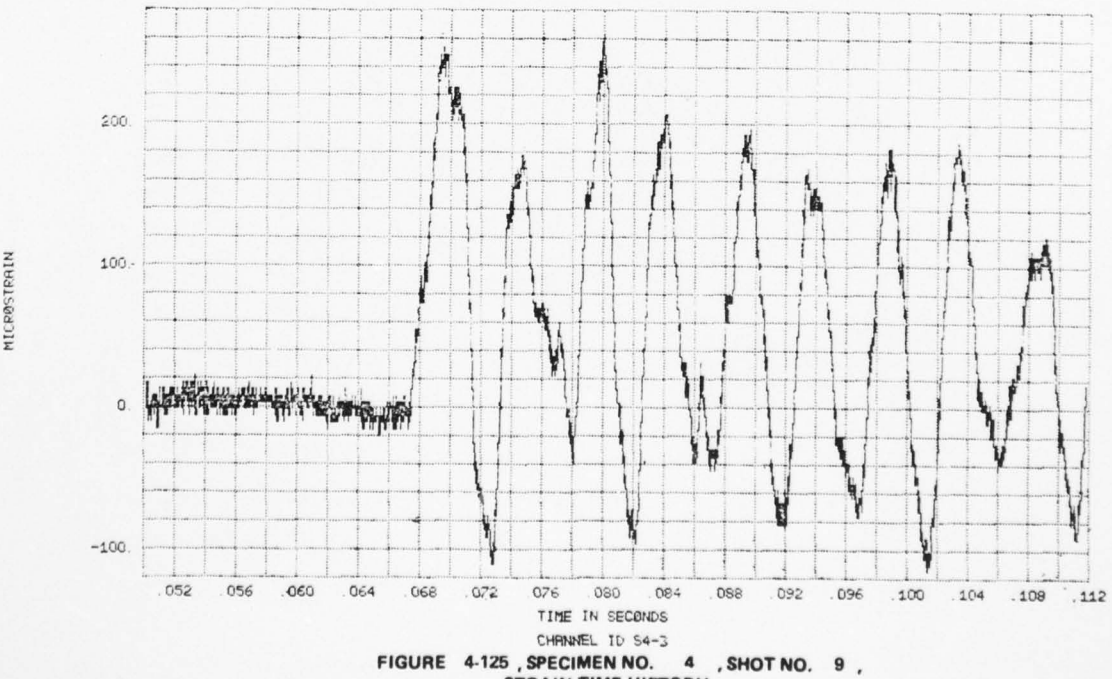


FIGURE 4-125 , SPECIMEN NO. 4 , SHOT NO. 9 , STRAIN TIME HISTORY

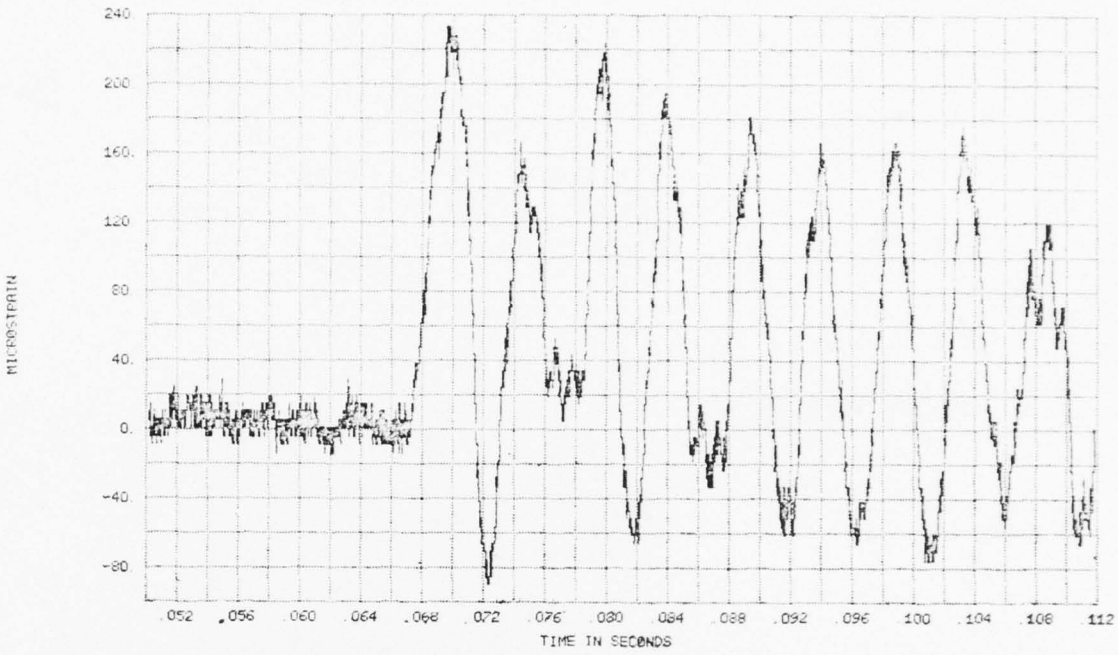


FIGURE 4-126 , SPECIMEN NO. 4 , SHOT NO. 9 , STRAIN TIME HISTORY

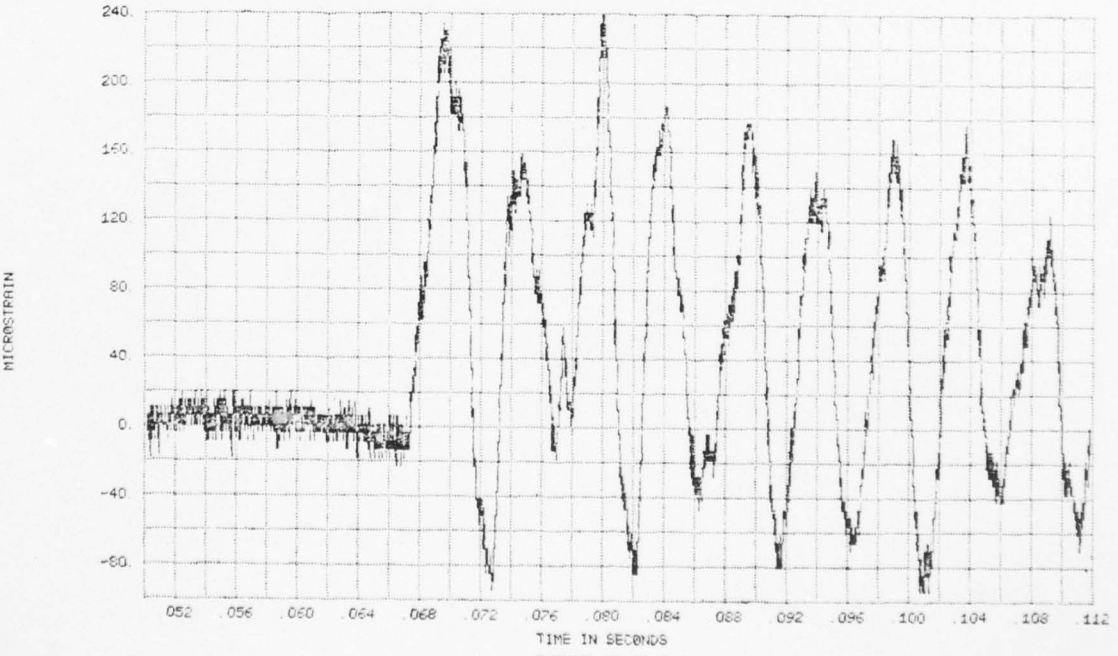


FIGURE 4-127 , SPECIMEN NO. 4 , SHOT NO. 9 , STRAIN TIME HISTORY

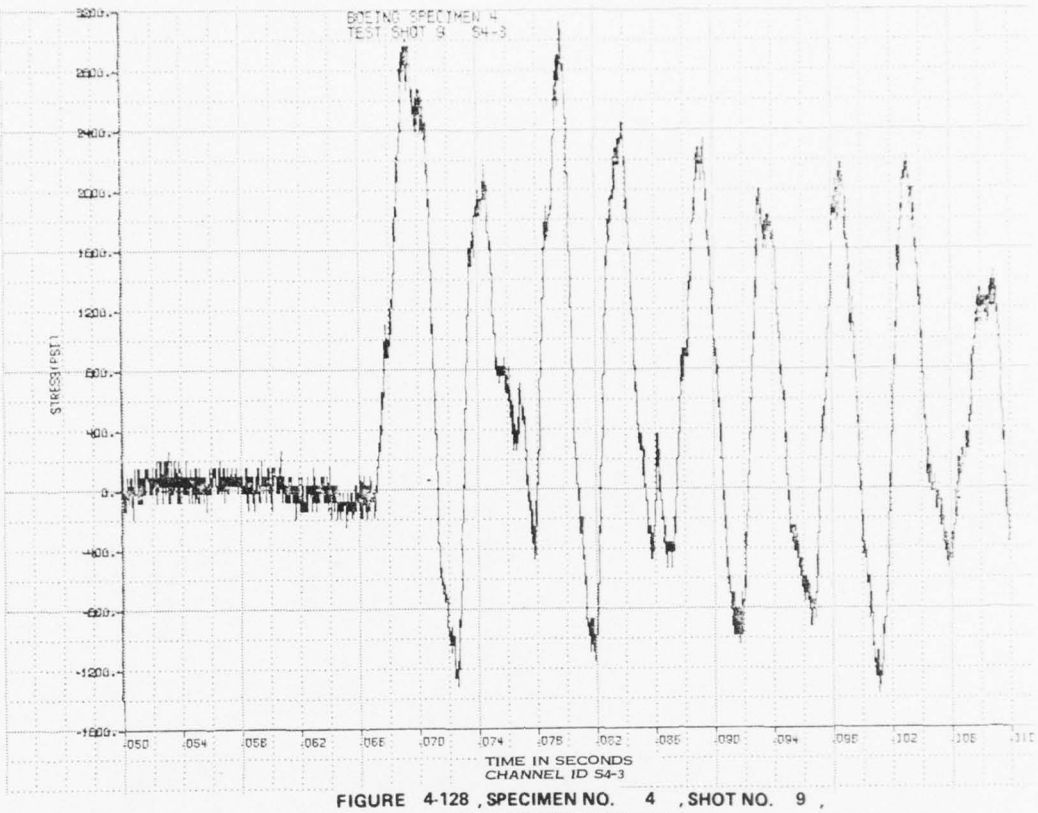


FIGURE 4-128 , SPECIMEN NO. 4 , SHOT NO. 9 ,
STRESS TIME HISTORY

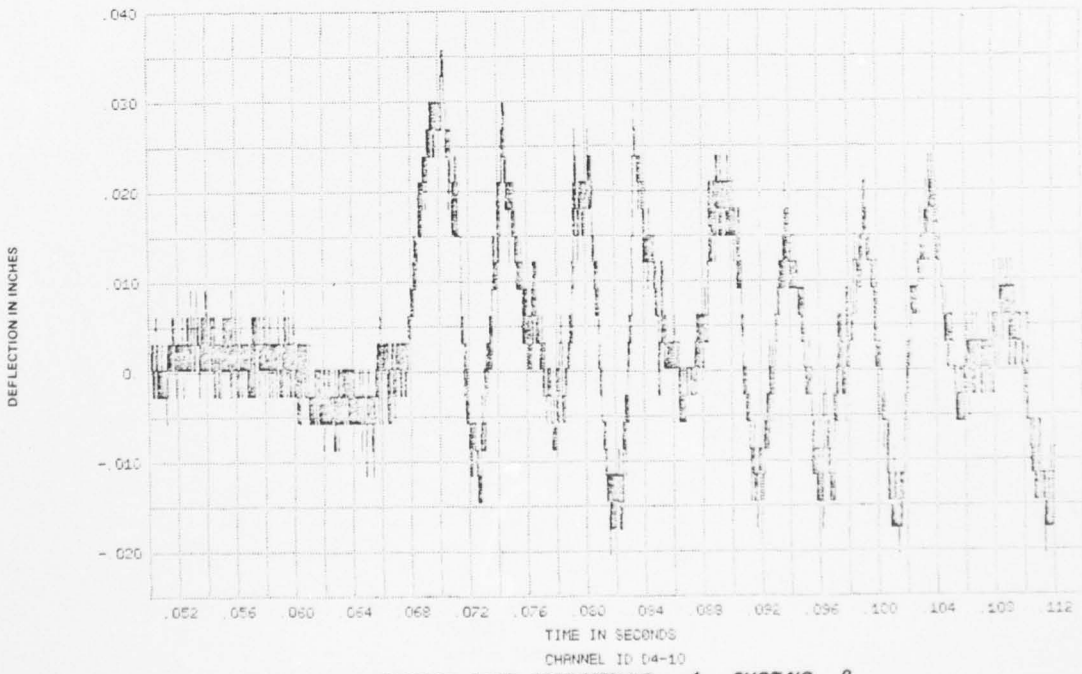


FIGURE 4-129 , SPECIMEN NO. 4 , SHOT NO. 9 .
DEFLECTION TIME HISTORY

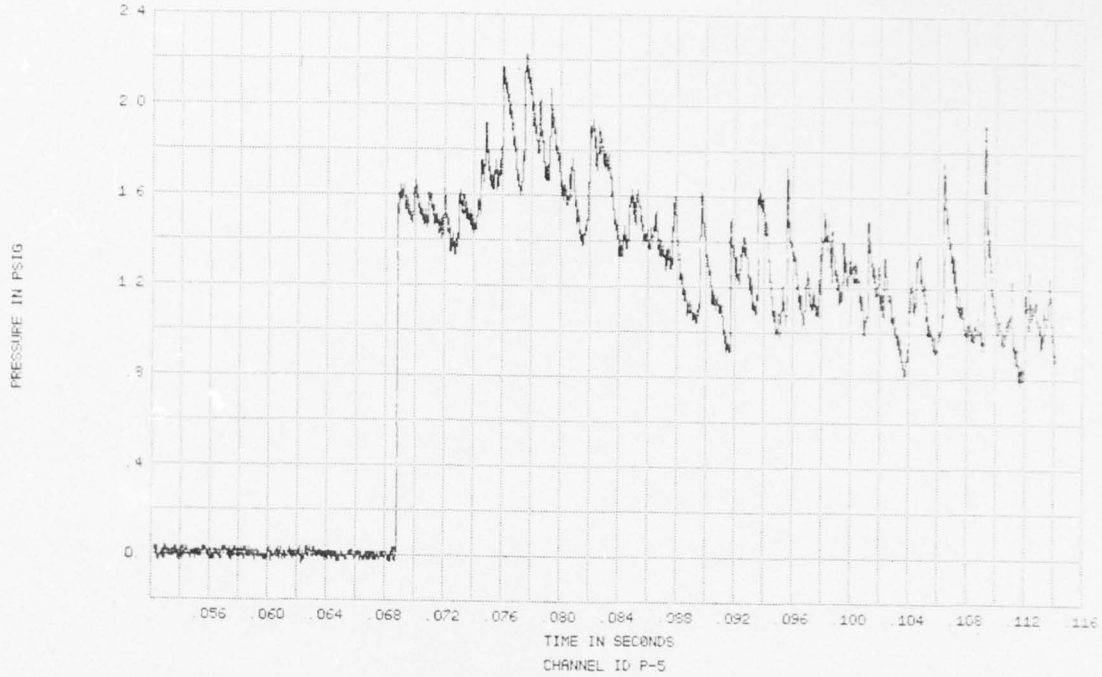


FIGURE 4-130 , SPECIMEN NO. 4 , SHOT NO. 10 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

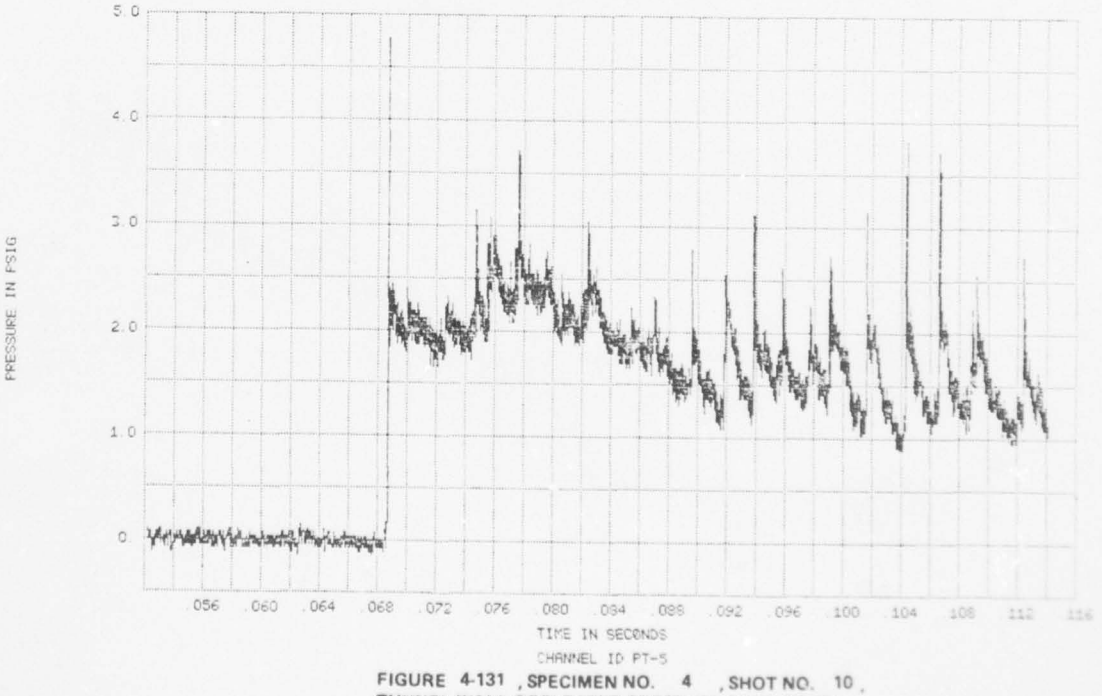
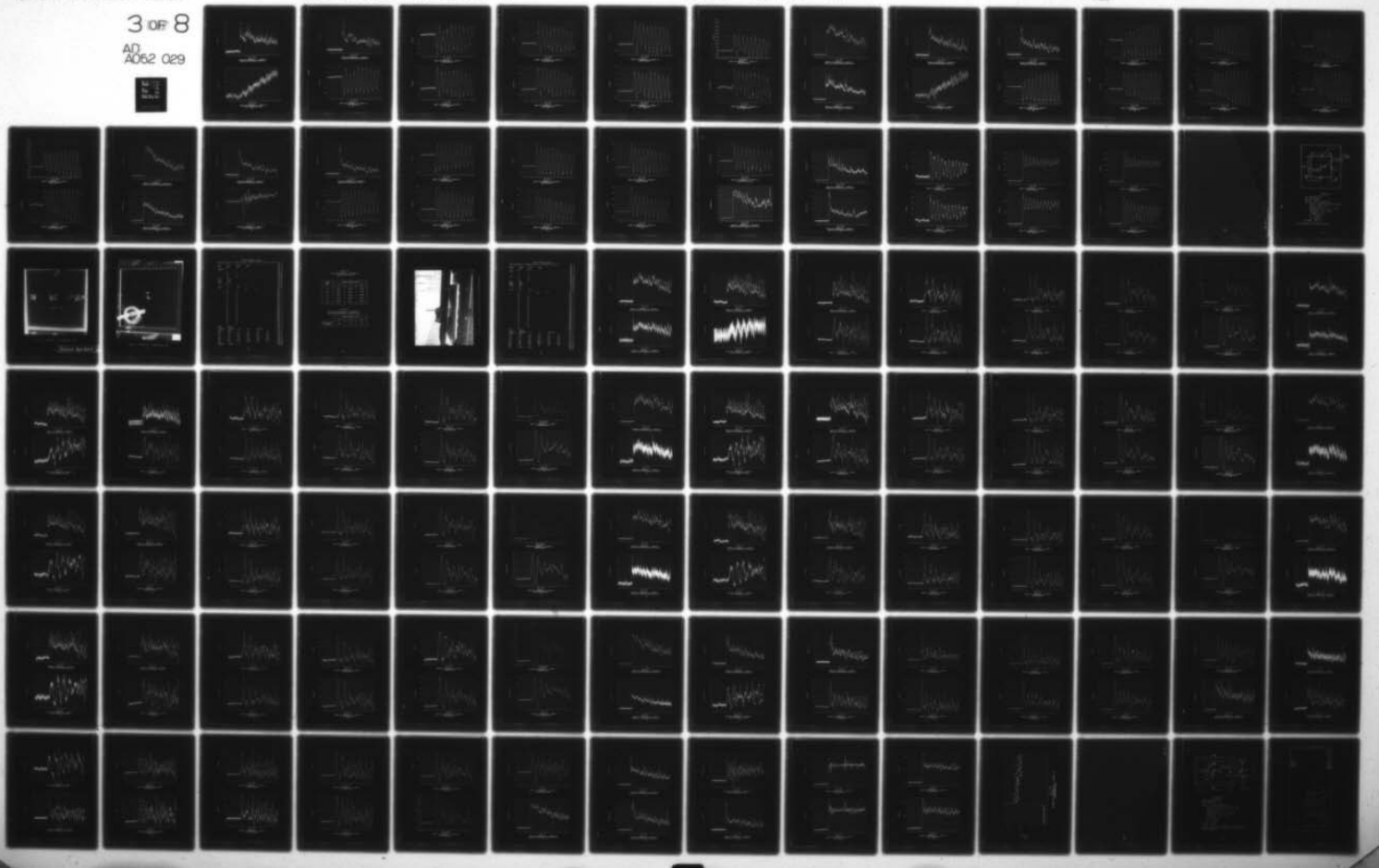
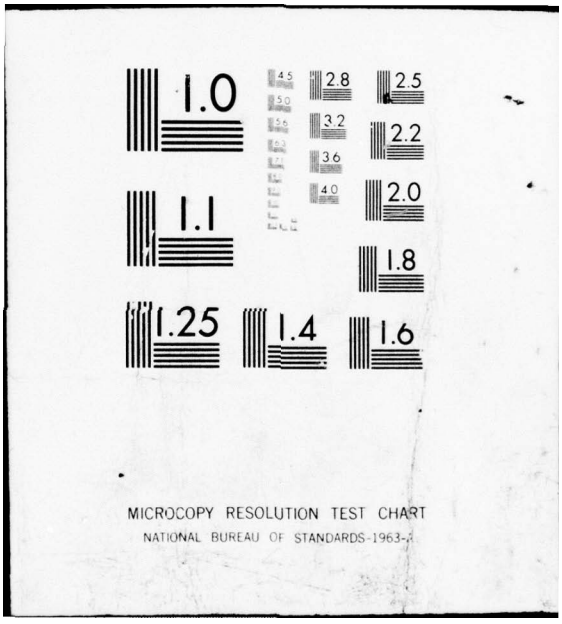


FIGURE 4-131 , SPECIMEN NO. 4 , SHOT NO. 10 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

AD-A052 029 BOEING WICHITA CO KS F/G 18/3
STRUCTURAL RESPONSE TO SIMULATED NUCLEAR OVERPRESSURE (STRESNO)--ETC(U)
MAR 77 R P SYRING, W D PIERSON DNA001-76-C-0084
UNCLASSIFIED D3-9788-5-VOL-2 DNA-4278F-2 NL

3 OF 8
AD A052 029




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
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6.3
7.1
8.0
9.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

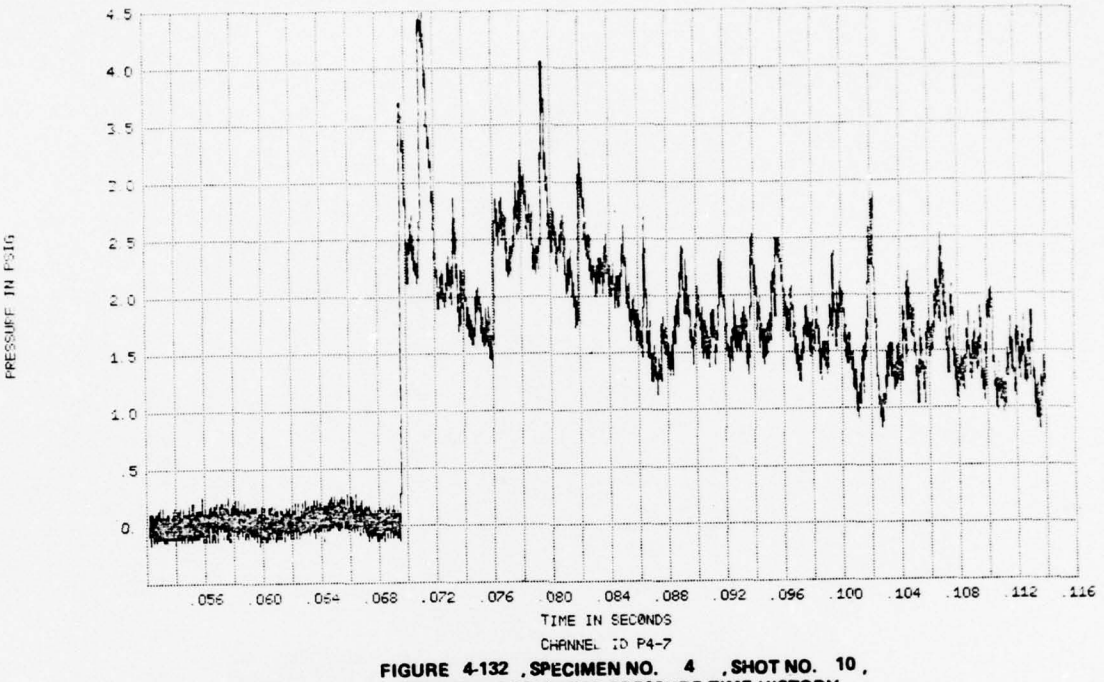


FIGURE 4-132 , SPECIMEN NO. 4 , SHOT NO. 10 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

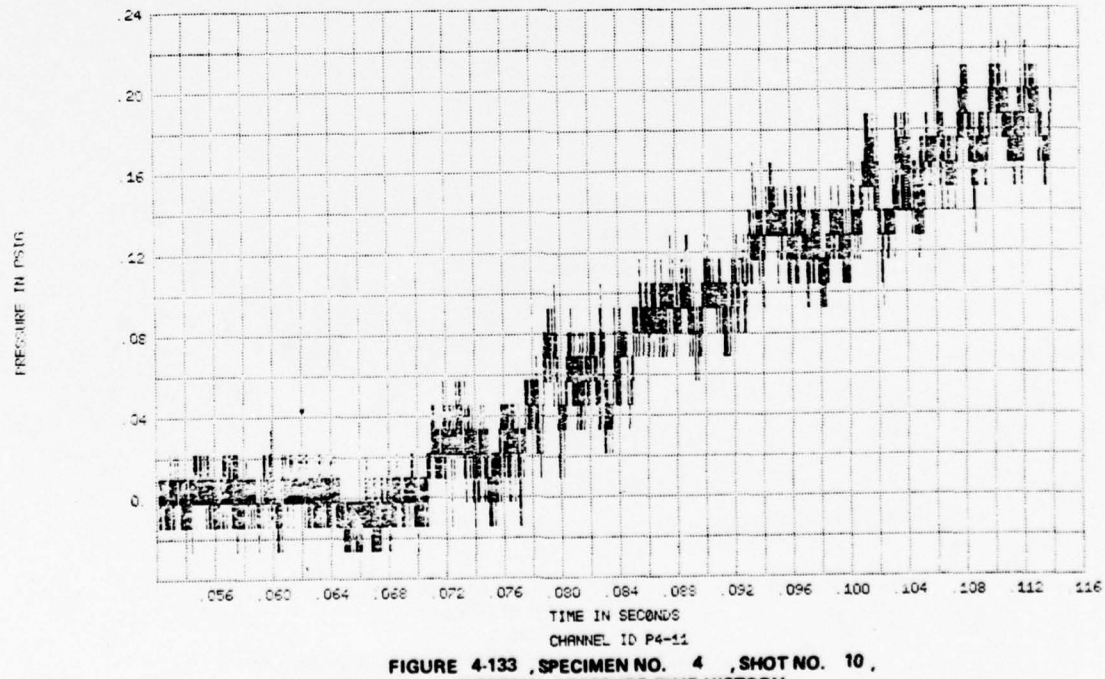


FIGURE 4-133 , SPECIMEN NO. 4 , SHOT NO. 10 ,
INTERNAL PRESSURE TIME HISTORY

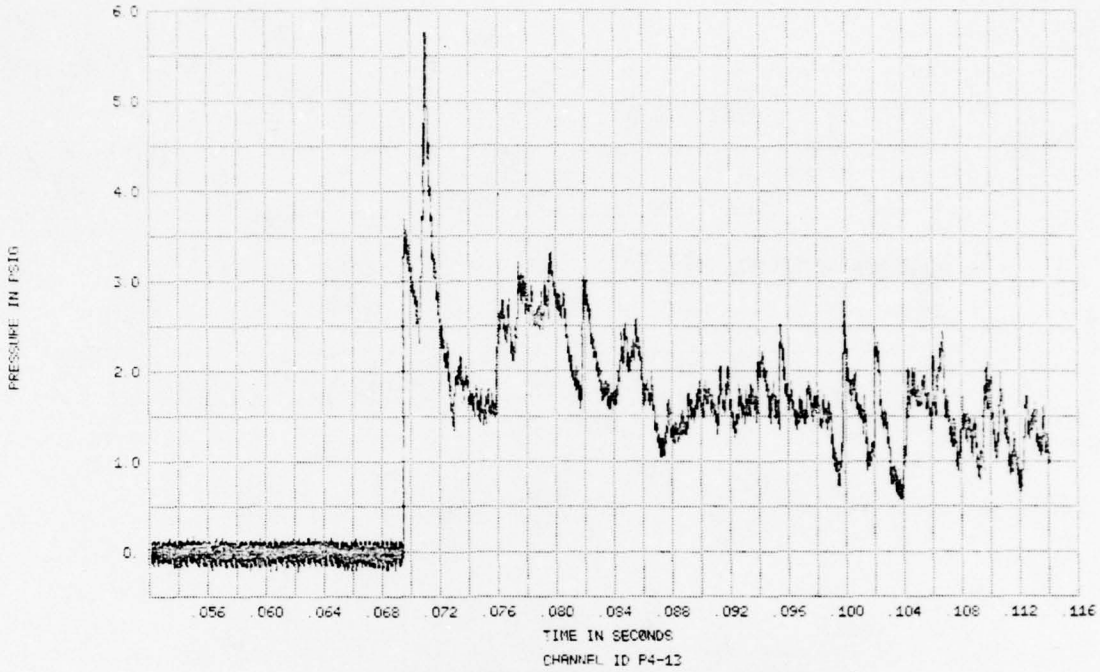


FIGURE 4-134 , SPECIMEN NO. 4 , SHOT NO. 10 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

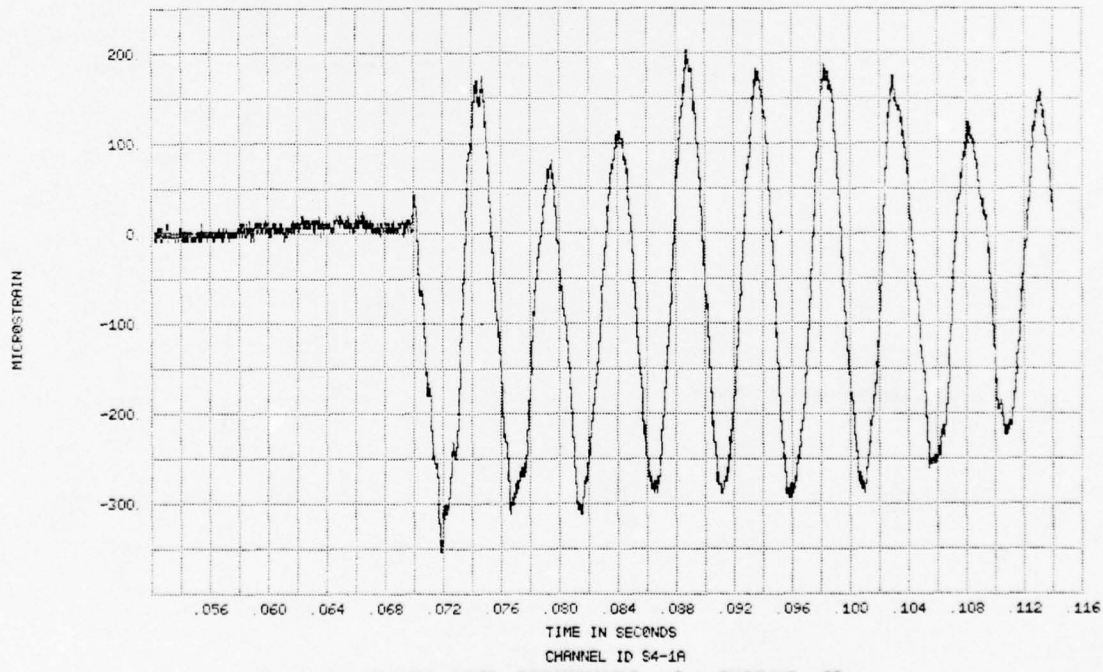


FIGURE 4-135 , SPECIMEN NO. 4 , SHOT NO. 10 ,
STRAIN TIME HISTORY

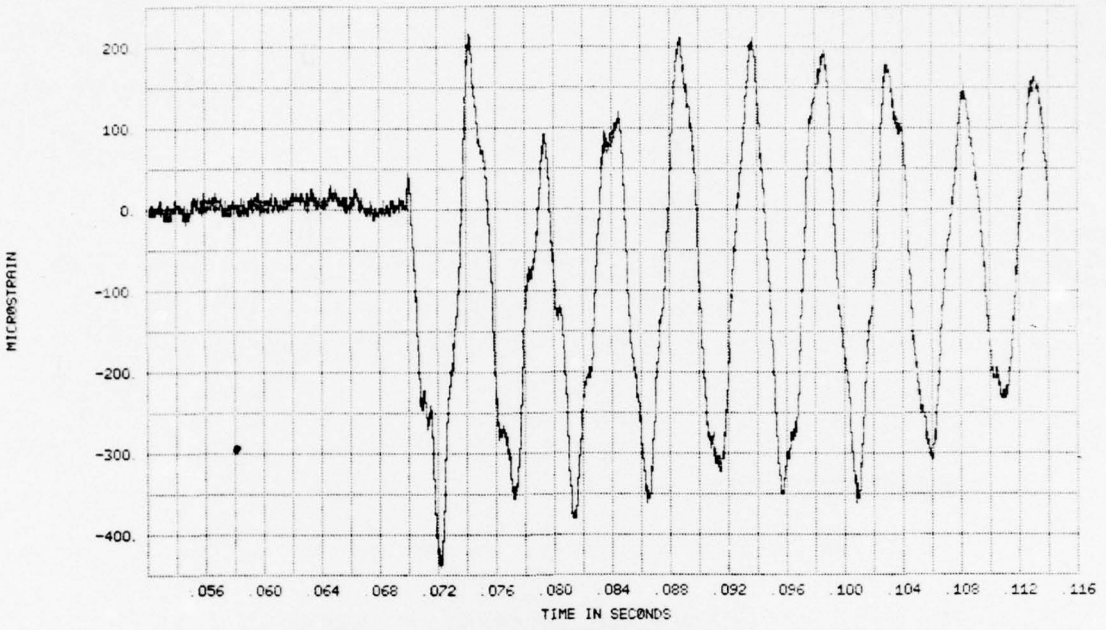


FIGURE 4-136 , SPECIMEN NO. 4 , SHOT NO. 10 ,
STRAIN TIME HISTORY

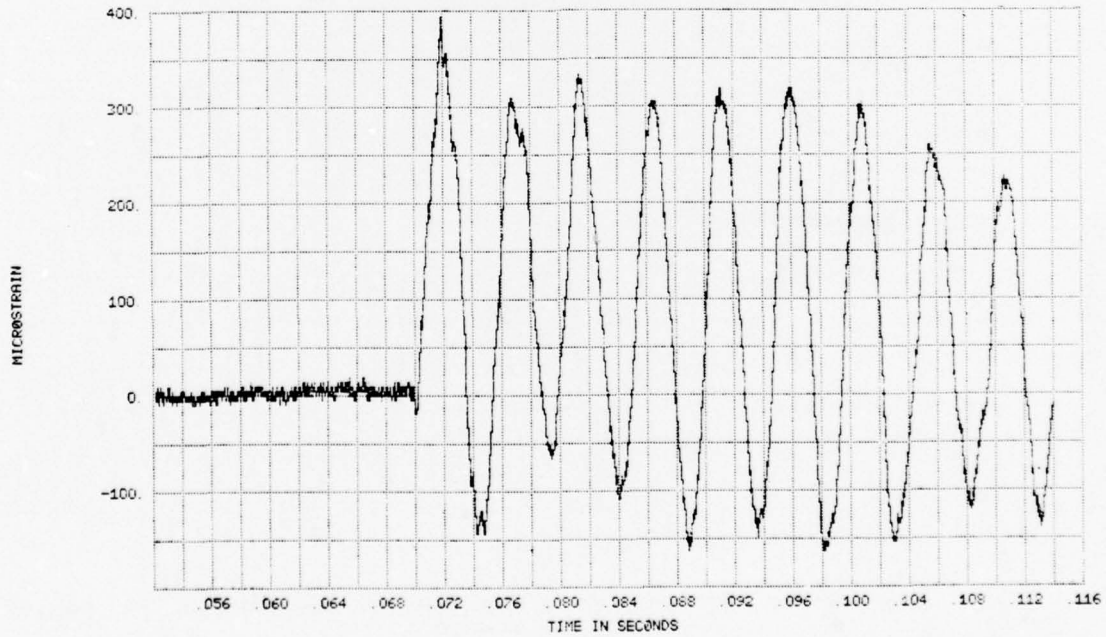


FIGURE 4-137 , SPECIMEN NO. 4 , SHOT NO. 10 ,
STRAIN TIME HISTORY

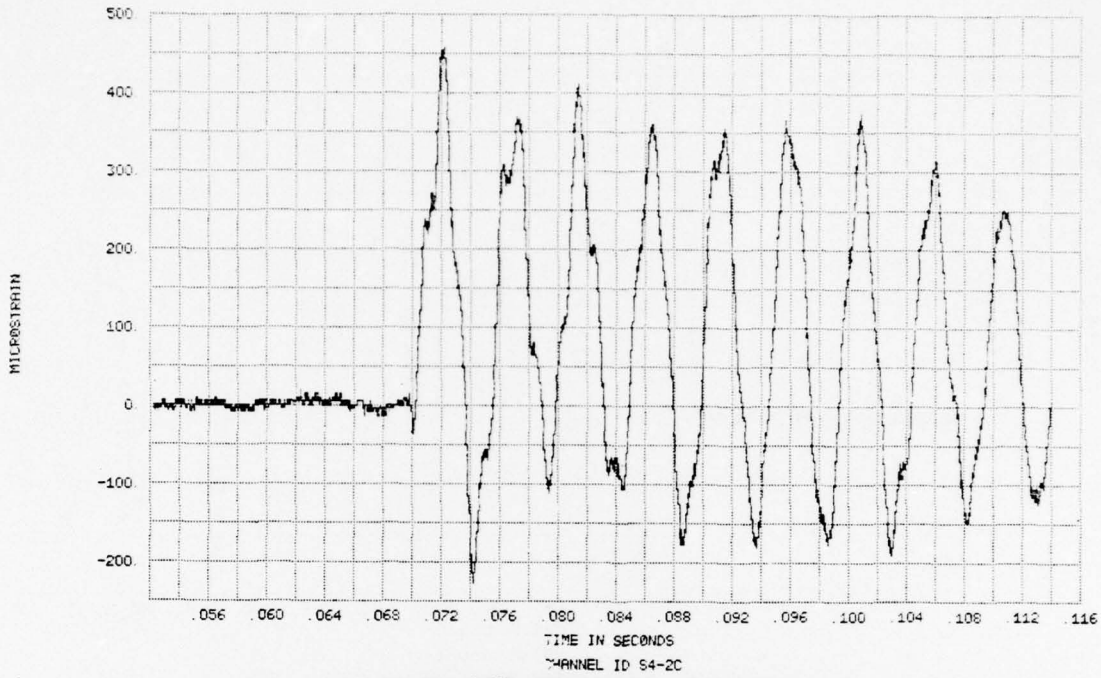


FIGURE 4-138 , SPECIMEN NO. 4 , SHOT NO. 10 , STRAIN TIME HISTORY

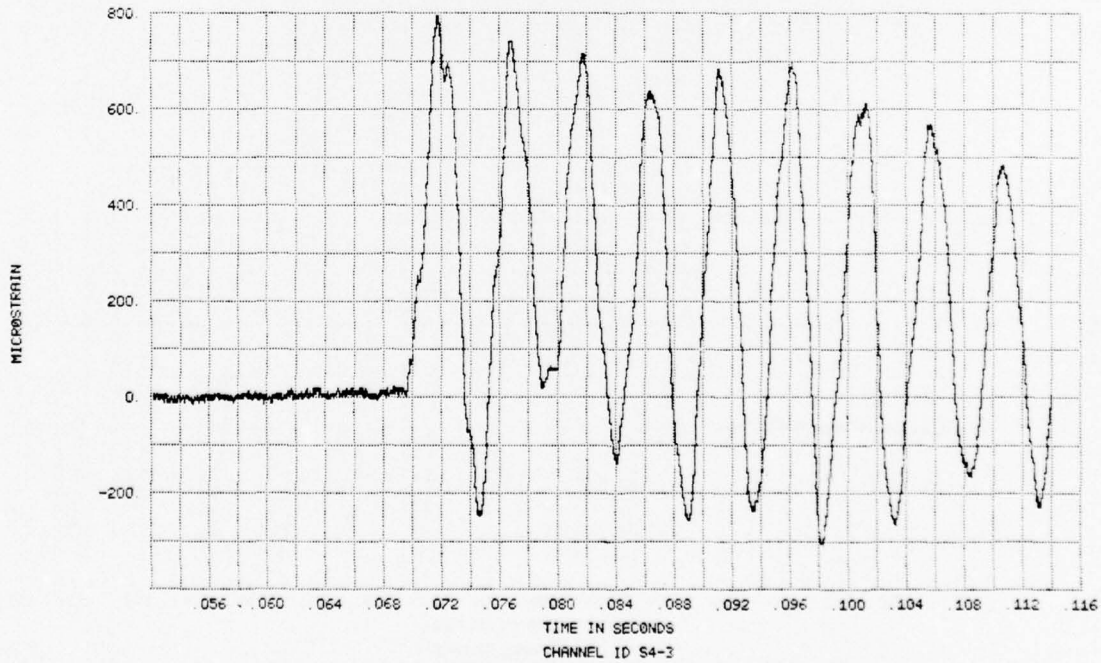


FIGURE 4-139 , SPECIMEN NO. 4 , SHOT NO. 10 , STRAIN TIME HISTORY

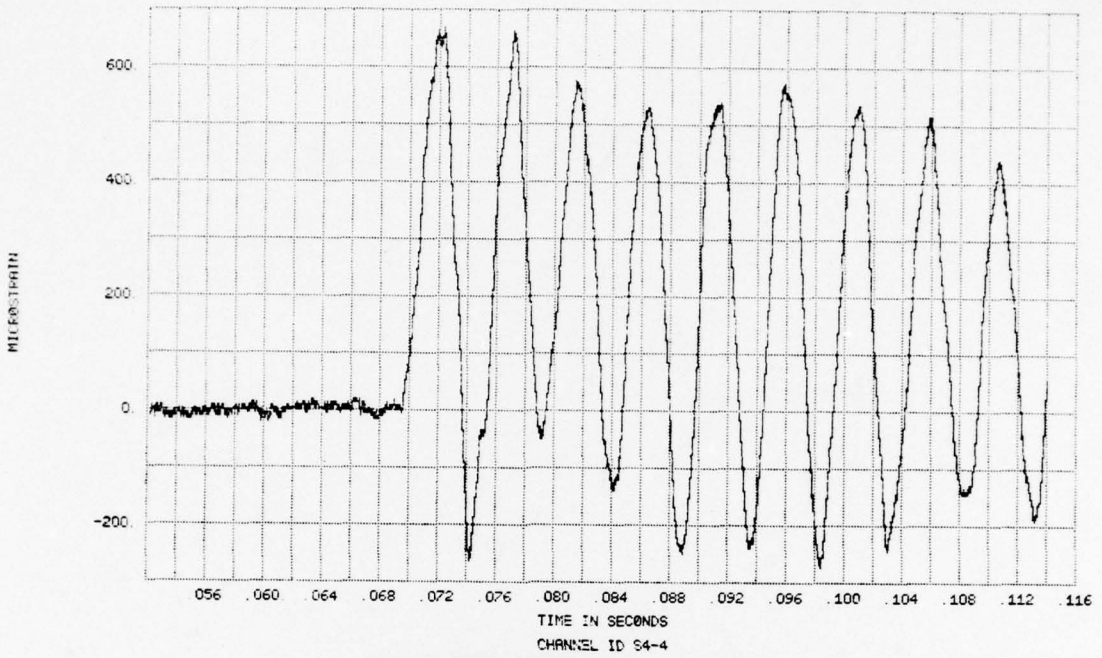


FIGURE 4-140 , SPECIMEN NO. 4 , SHOT NO. 10 , STRAIN TIME HISTORY

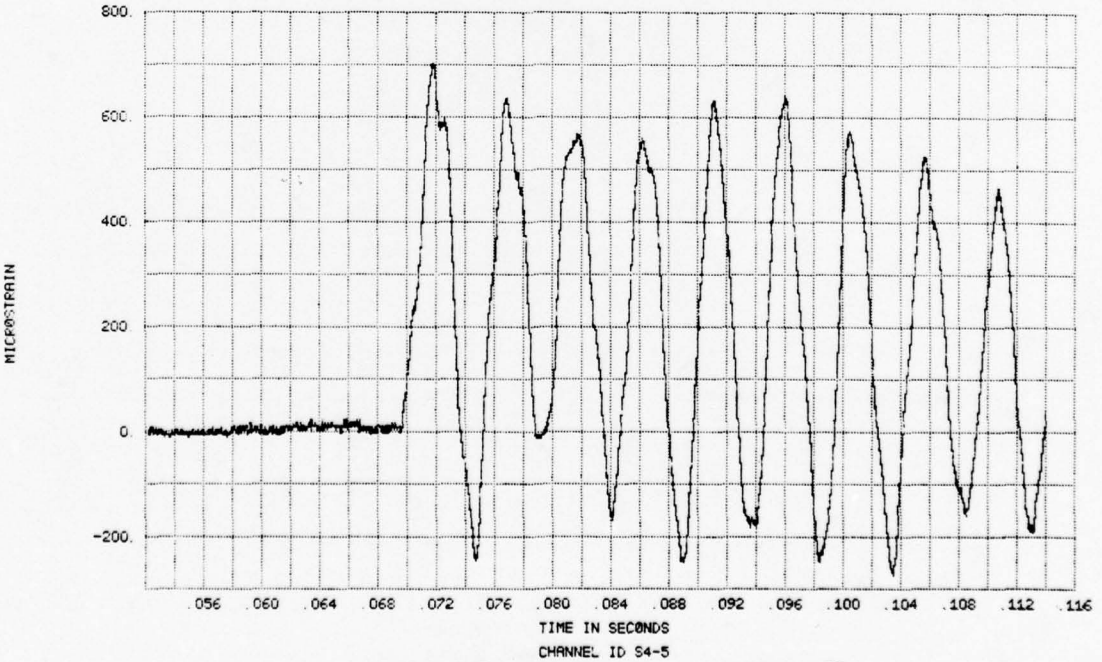


FIGURE 4-141 , SPECIMEN NO. 4 , SHOT NO. 10 , STRAIN TIME HISTORY

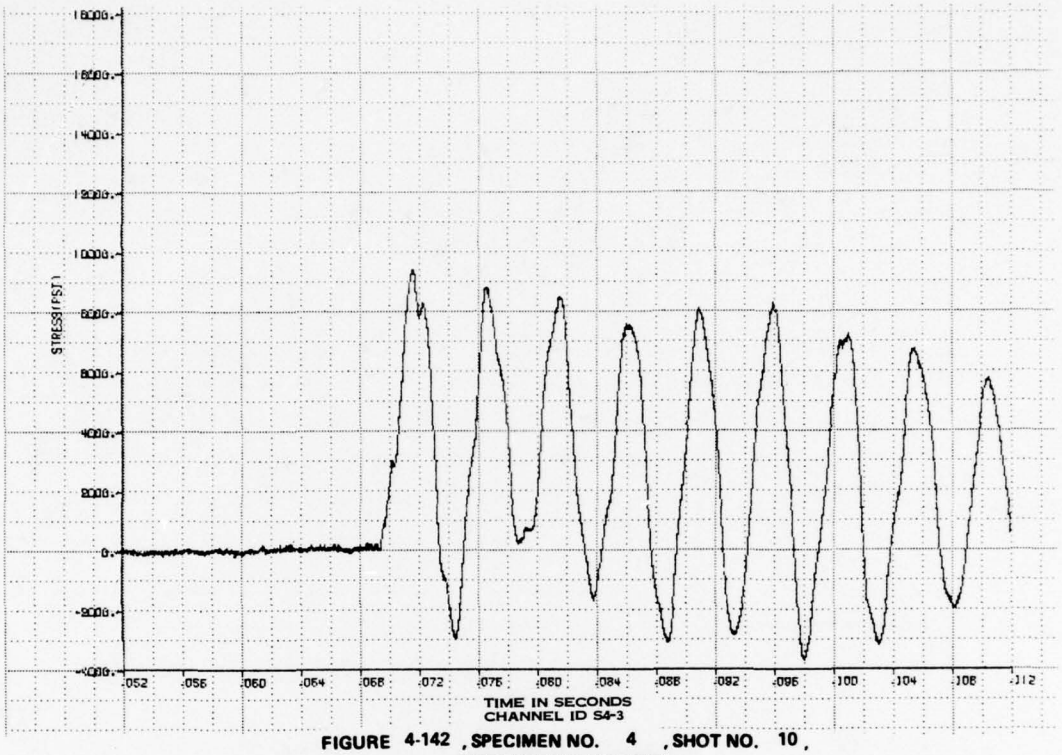


FIGURE 4-142 , SPECIMEN NO. 4 , SHOT NO. 10 ,
STRESS TIME HISTORY

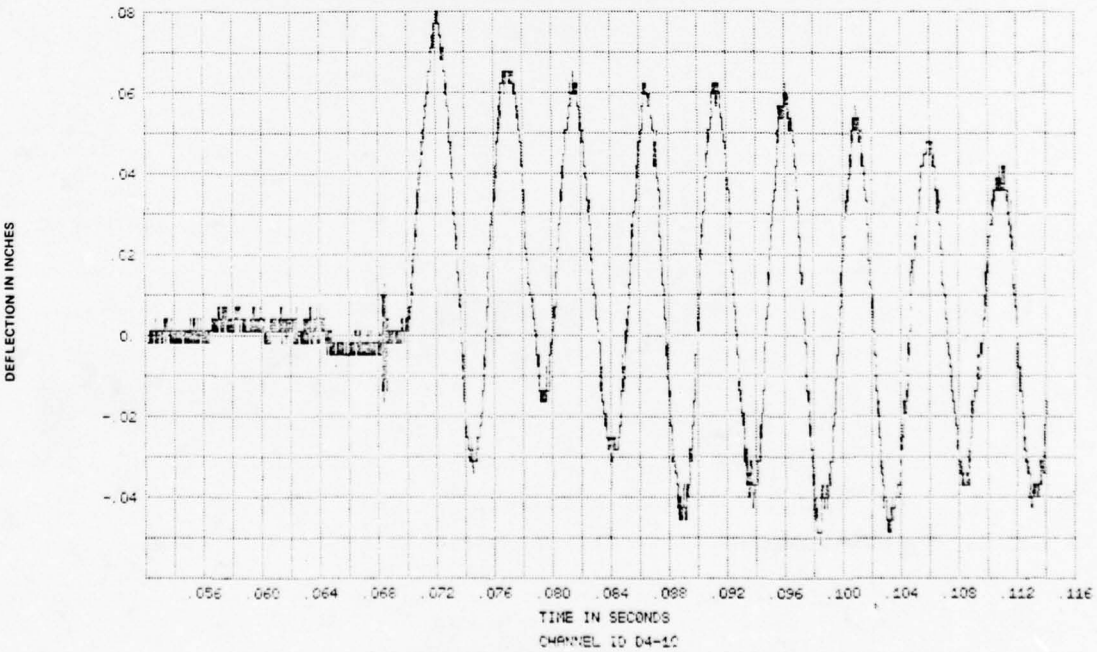


FIGURE 4-143 , SPECIMEN NO. 4 , SHOT NO. 10 ,
DEFLECTION TIME HISTORY

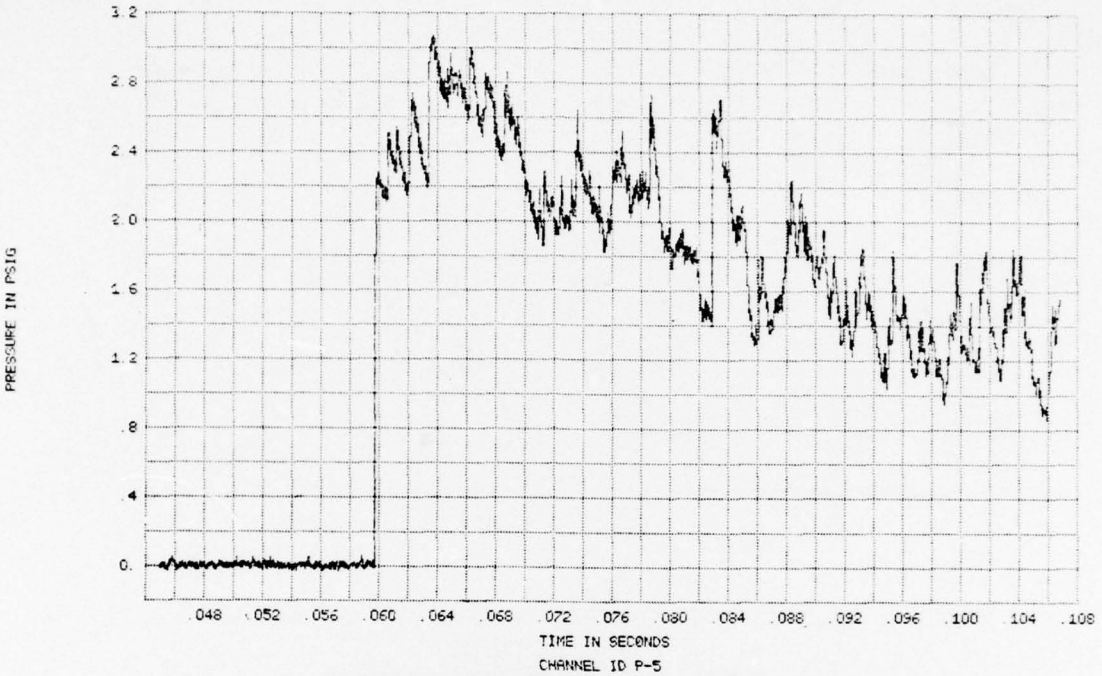


FIGURE 4-144 , SPECIMEN NO. 4 , SHOT NO. 11 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

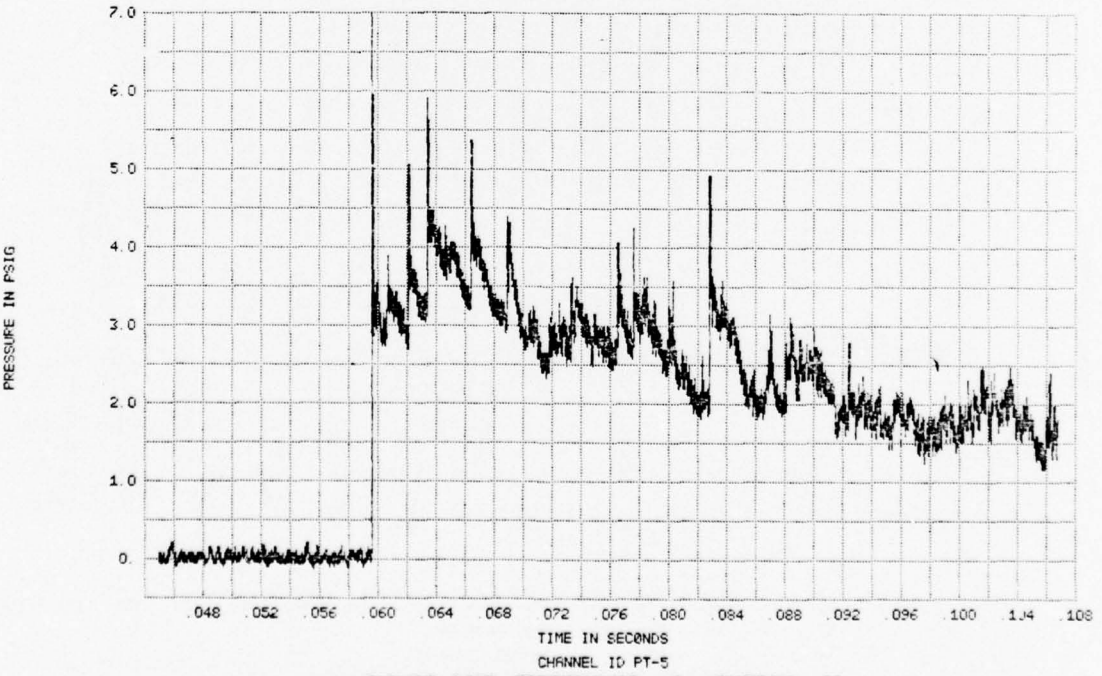


FIGURE 4-145 , SPECIMEN NO. 4 , SHOT NO. 11 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

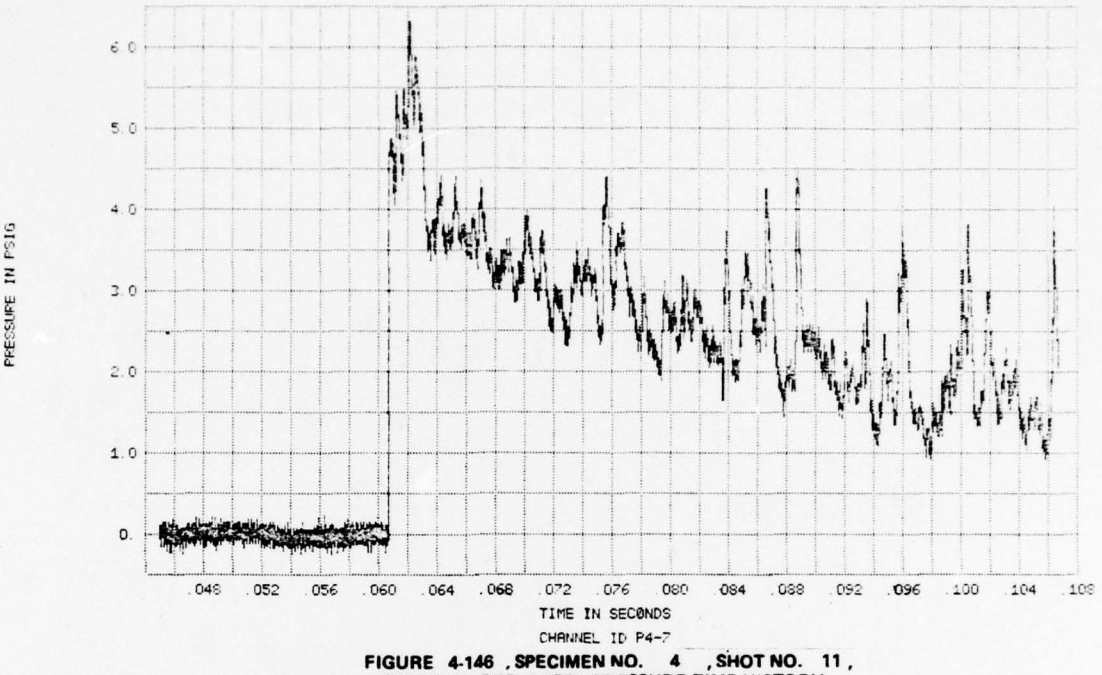


FIGURE 4-146 , SPECIMEN NO. 4 , SHOT NO. 11 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

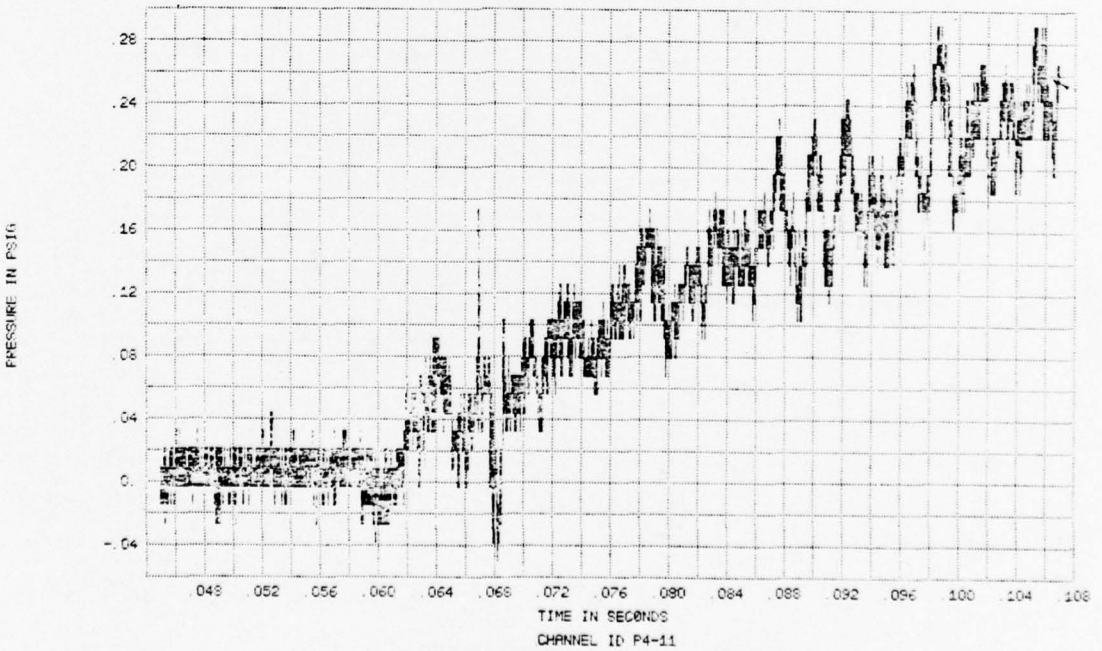


FIGURE 4-147 , SPECIMEN NO. 4 , SHOT NO. 11 ,
INTERNAL PRESSURE TIME HISTORY

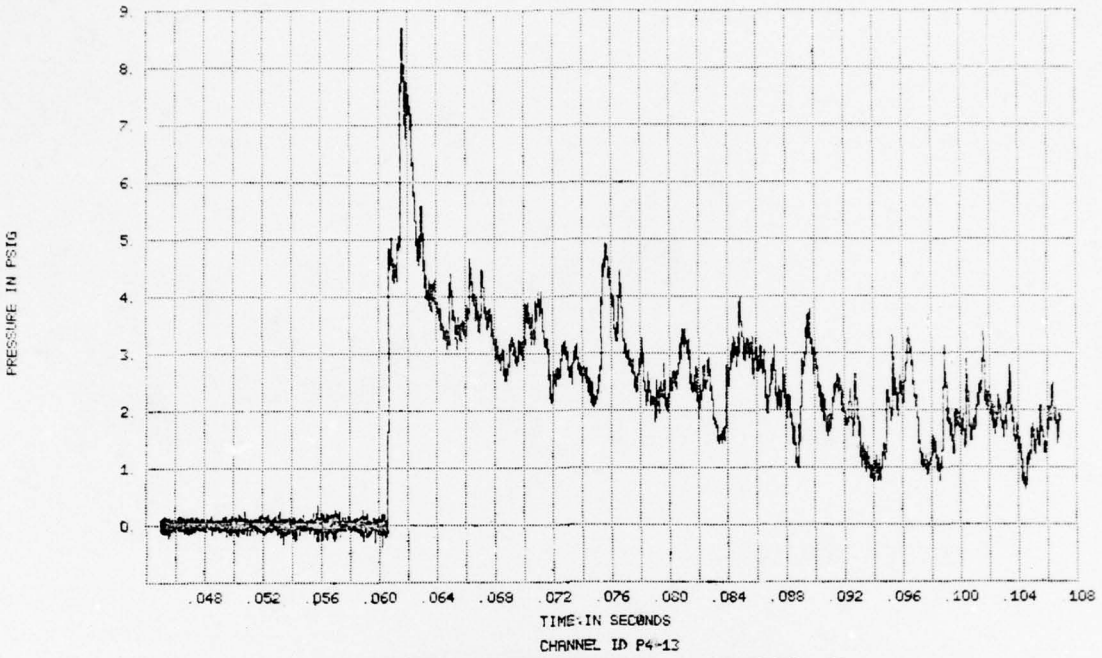


FIGURE 4-148 , SPECIMEN NO. 4 , SHOT NO. 11 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

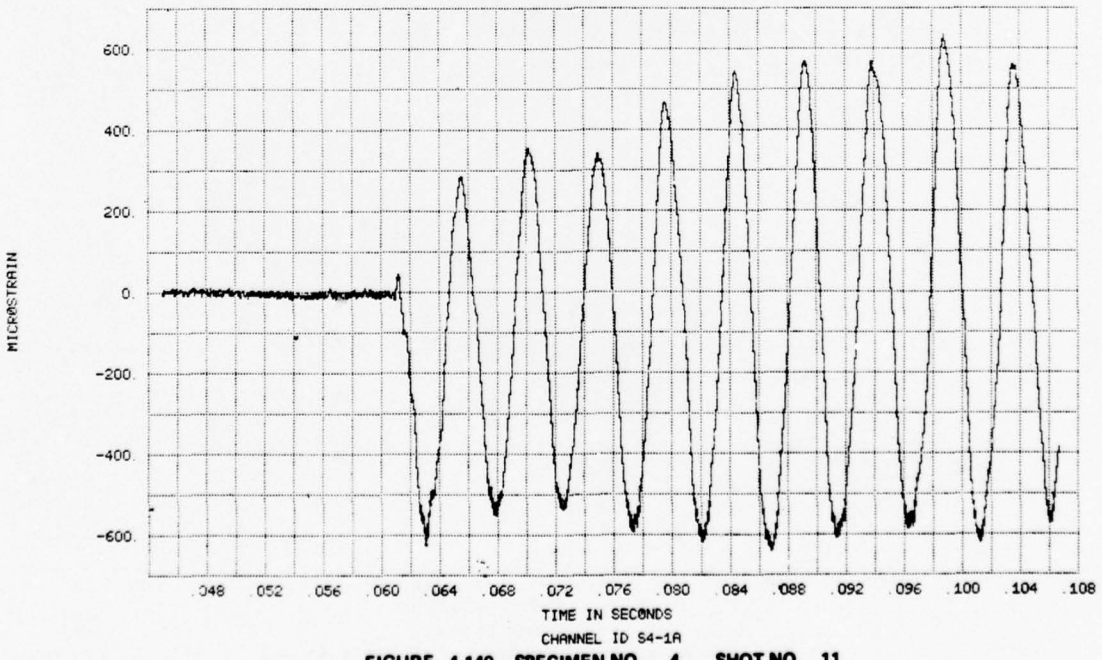


FIGURE 4-149 , SPECIMEN NO. 4 , SHOT NO. 11 .
STRAIN TIME HISTORY

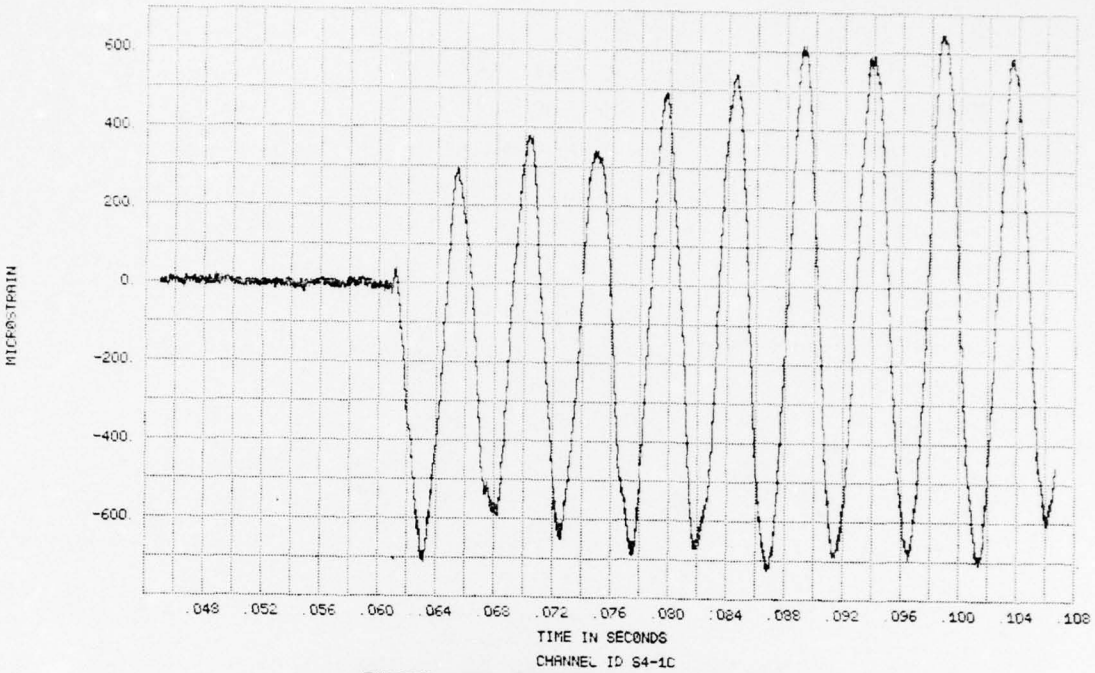


FIGURE 4-150 , SPECIMEN NO. 4 , SHOT NO. 11 , STRAIN TIME HISTORY

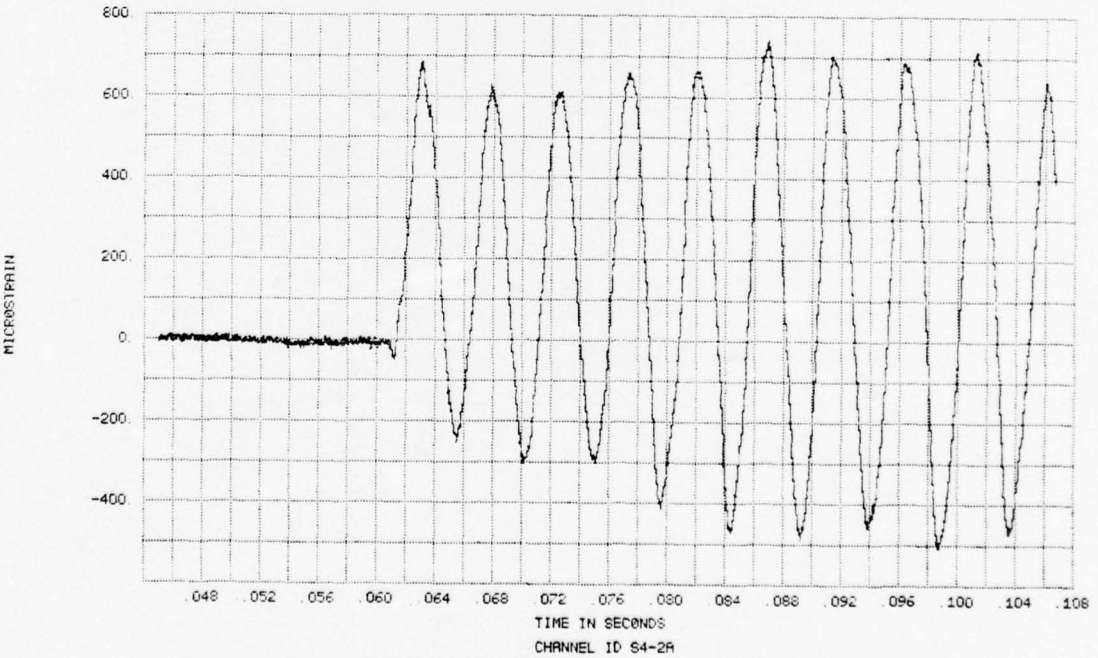


FIGURE 4-151 , SPECIMEN NO. 4 , SHOT NO. 11 , STRAIN TIME HISTORY

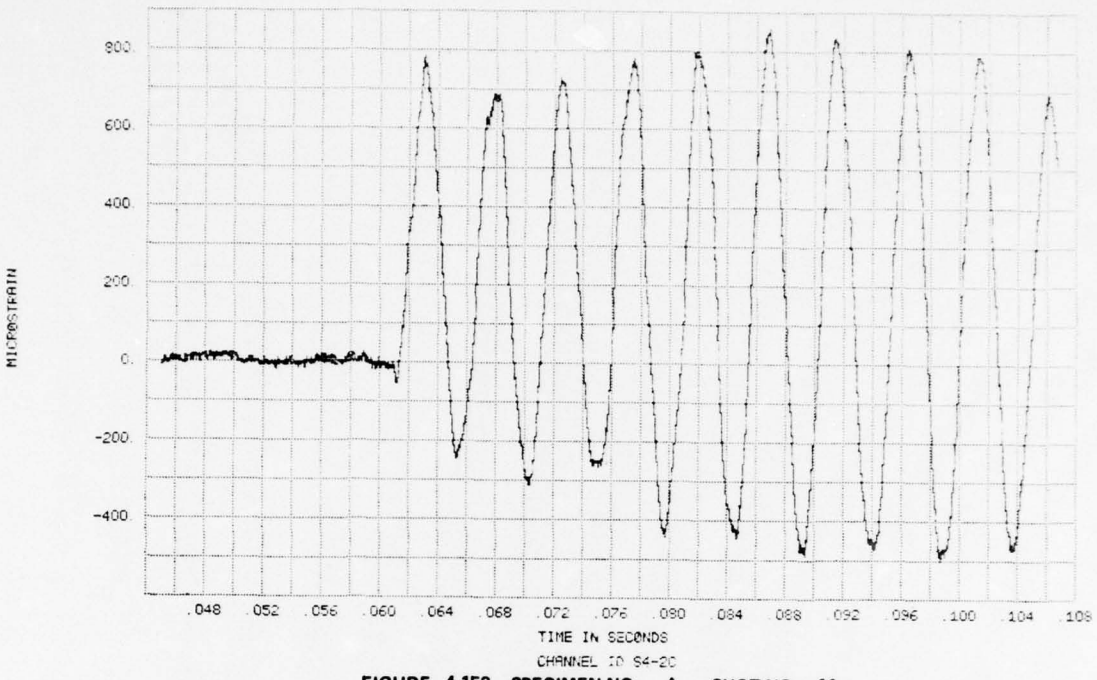


FIGURE 4-152 , SPECIMEN NO. 4 , SHOT NO. 11 , STRAIN TIME HISTORY

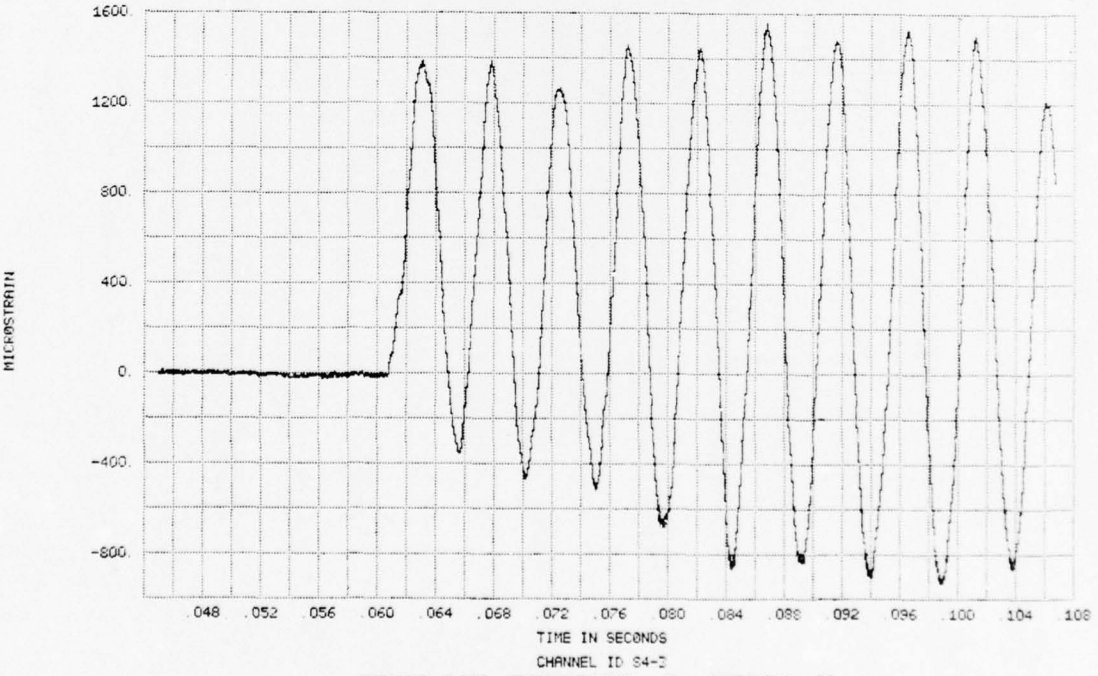


FIGURE 4-153 , SPECIMEN NO. 4 , SHOT NO. 11 , STRAIN TIME HISTORY

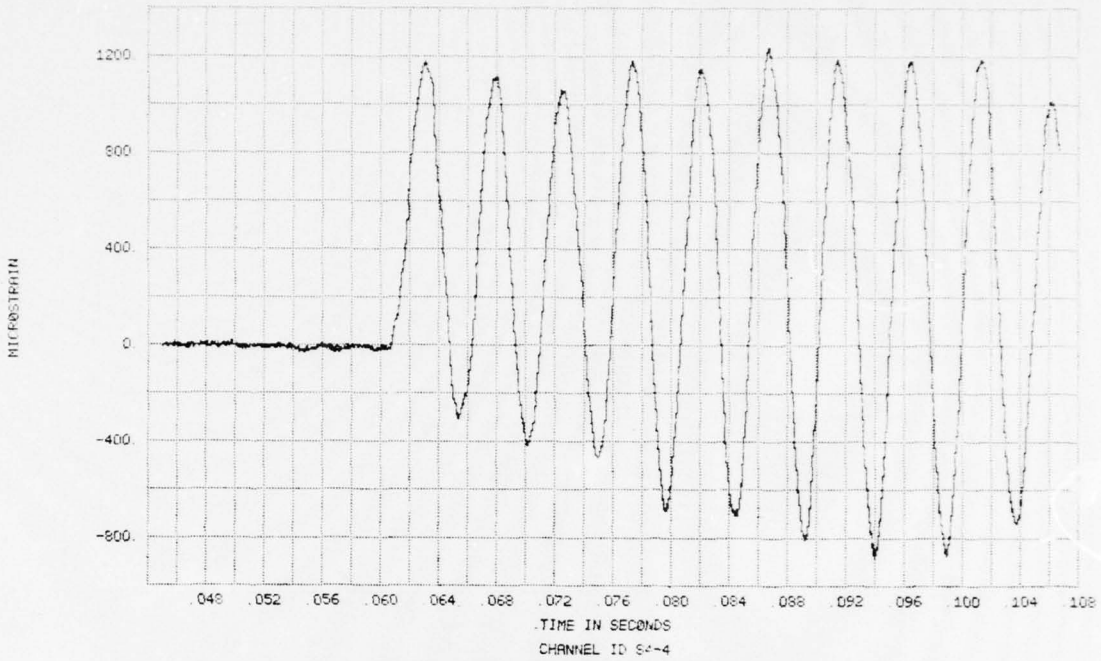


FIGURE 4-154 , SPECIMEN NO. 4 , SHOT NO. 11 , STRAIN TIME HISTORY

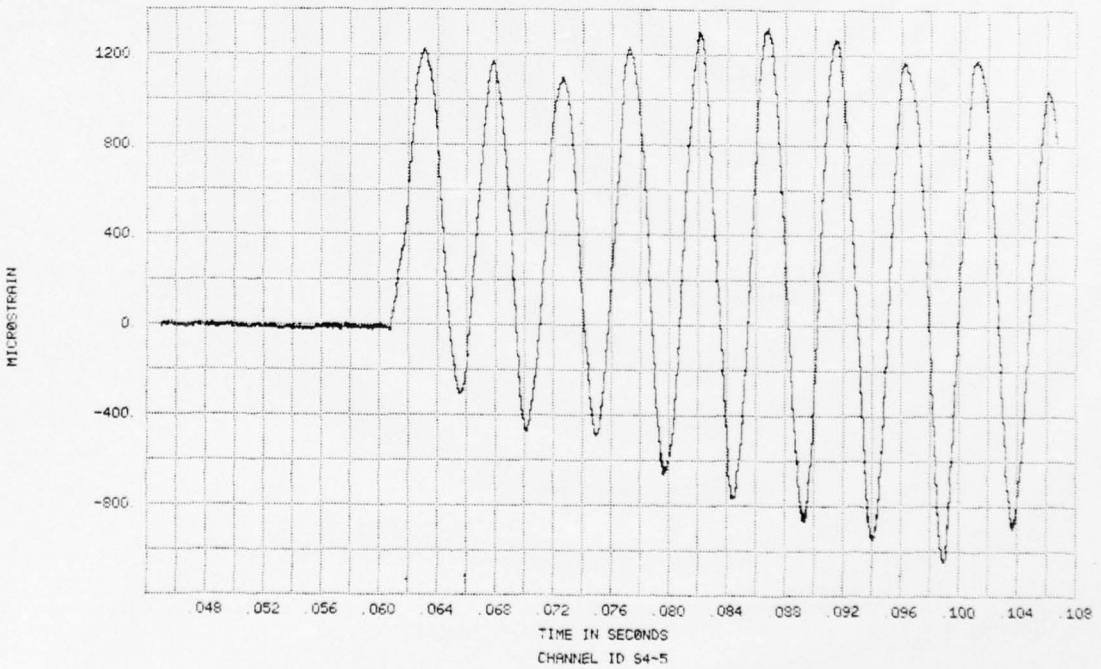


FIGURE 4-155 , SPECIMEN NO. 4 , SHOT NO. 11 , STRAIN TIME HISTORY

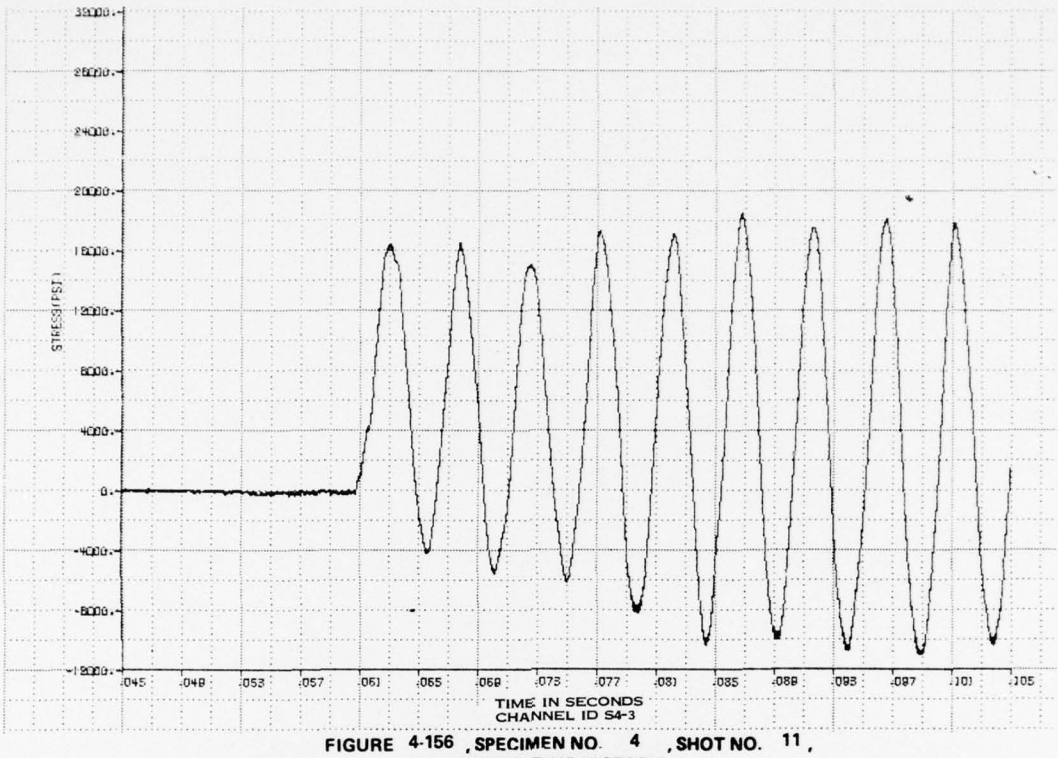


FIGURE 4-156 , SPECIMEN NO. 4 , SHOT NO. 11 ,
STRESS TIME HISTORY

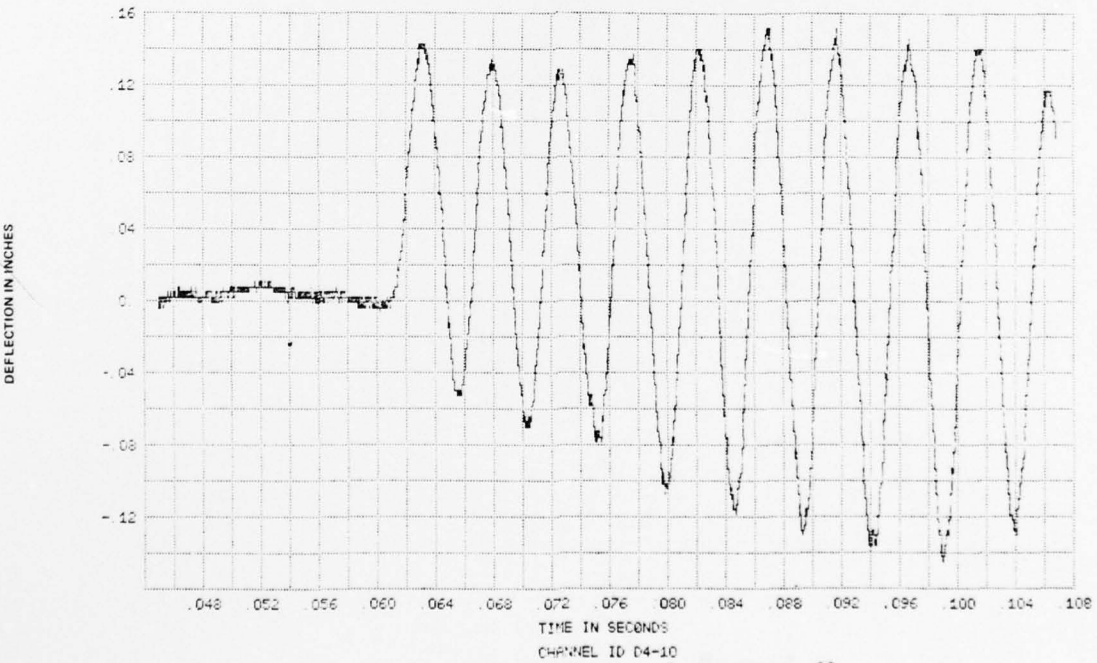


FIGURE 4-157 , SPECIMEN NO. 4 , SHOT NO. 11 ,
DEFLECTION TIME HISTORY

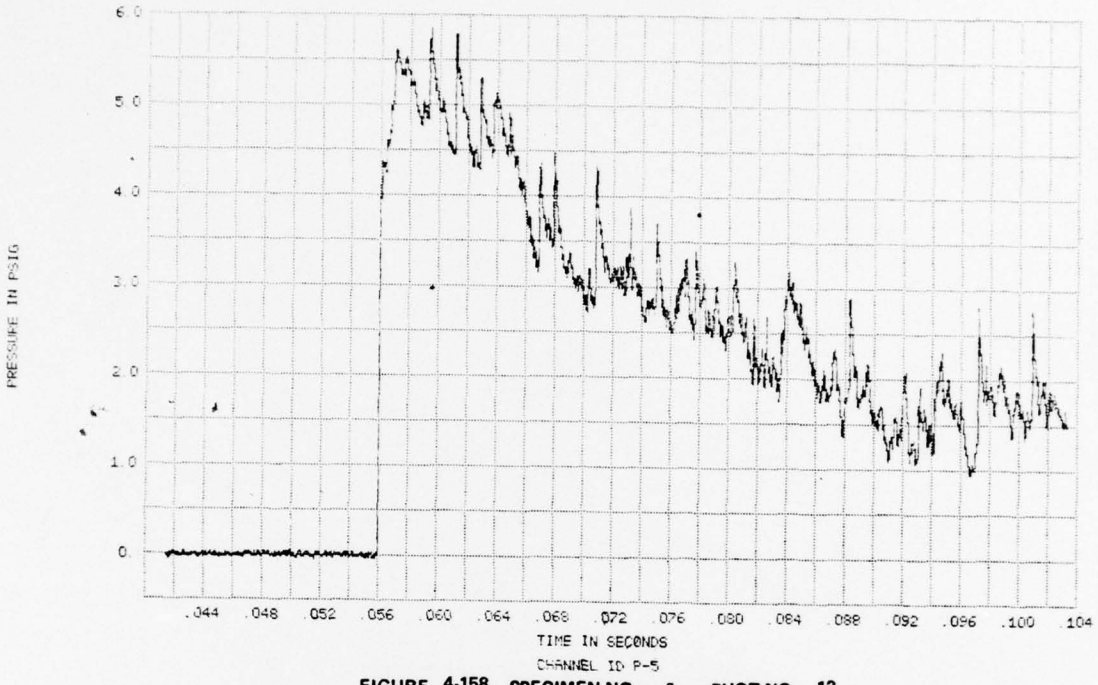


FIGURE 4-158 , SPECIMEN NO. 4 , SHOT NO. 12 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

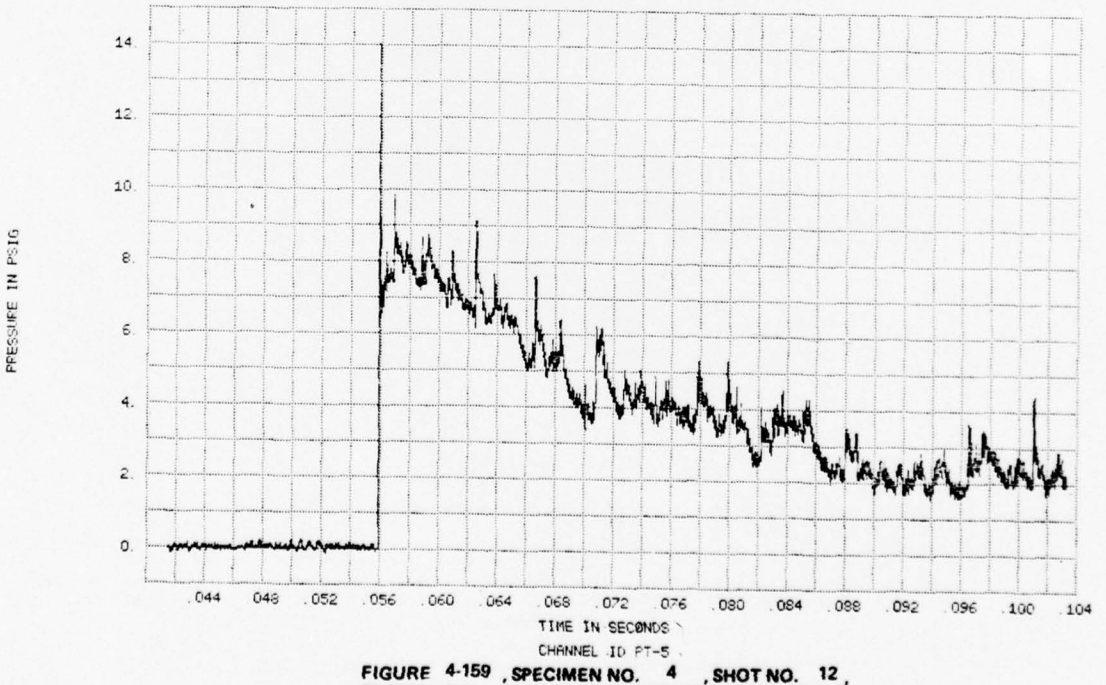


FIGURE 4-159 , SPECIMEN NO. 4 , SHOT NO. 12 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

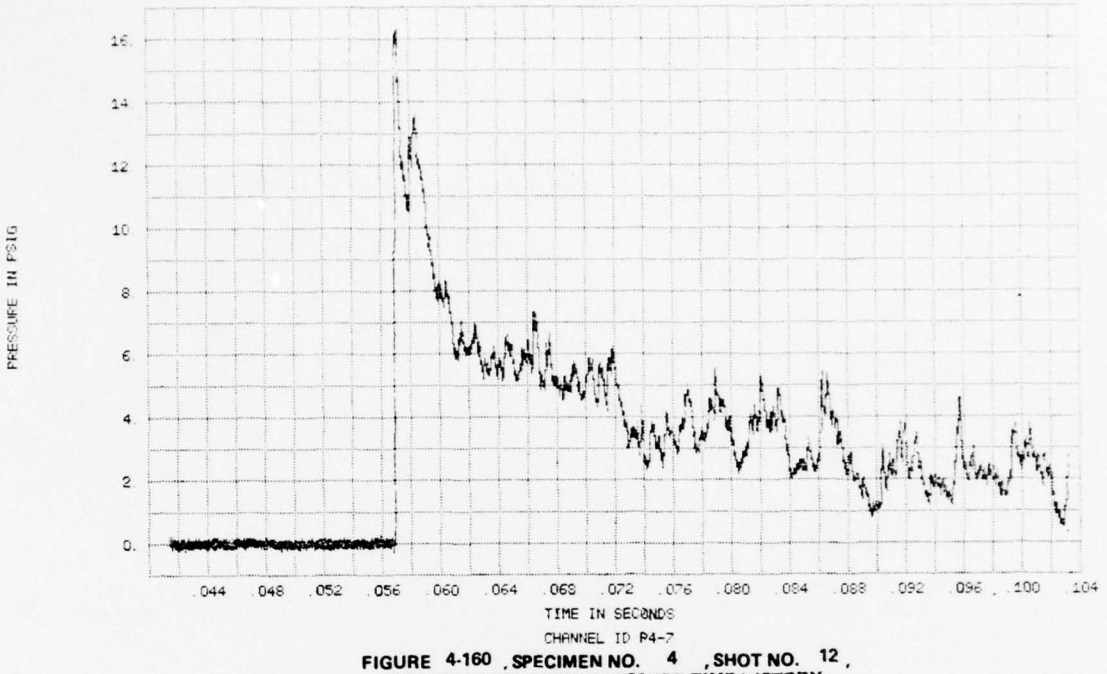


FIGURE 4-160 , SPECIMEN NO. 4 , SHOT NO. 12 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

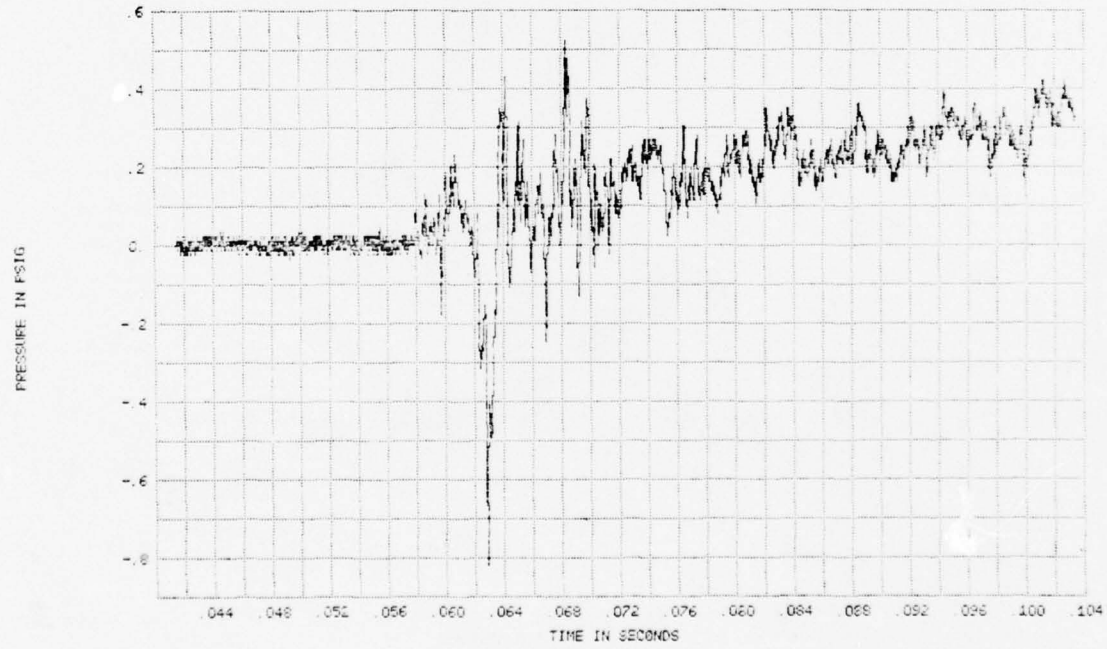


FIGURE 4-161 , SPECIMEN NO. 4 , SHOT NO. 12 ,
INTERNAL PRESSURE TIME HISTORY

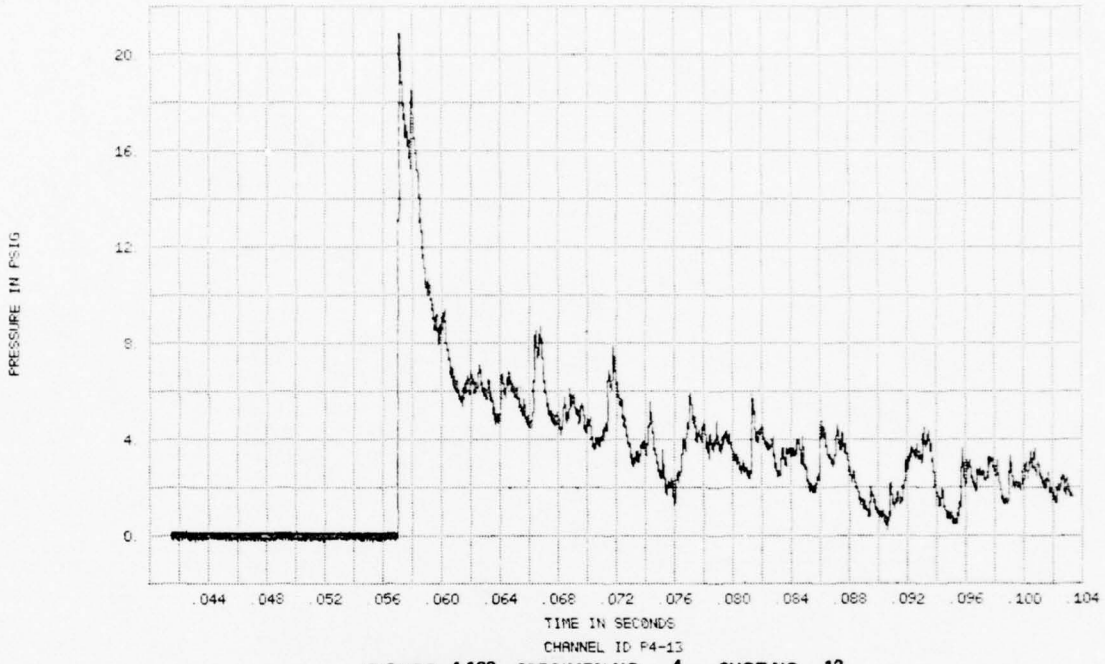


FIGURE 4-162 , SPECIMEN NO. 4 , SHOT NO. 12 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

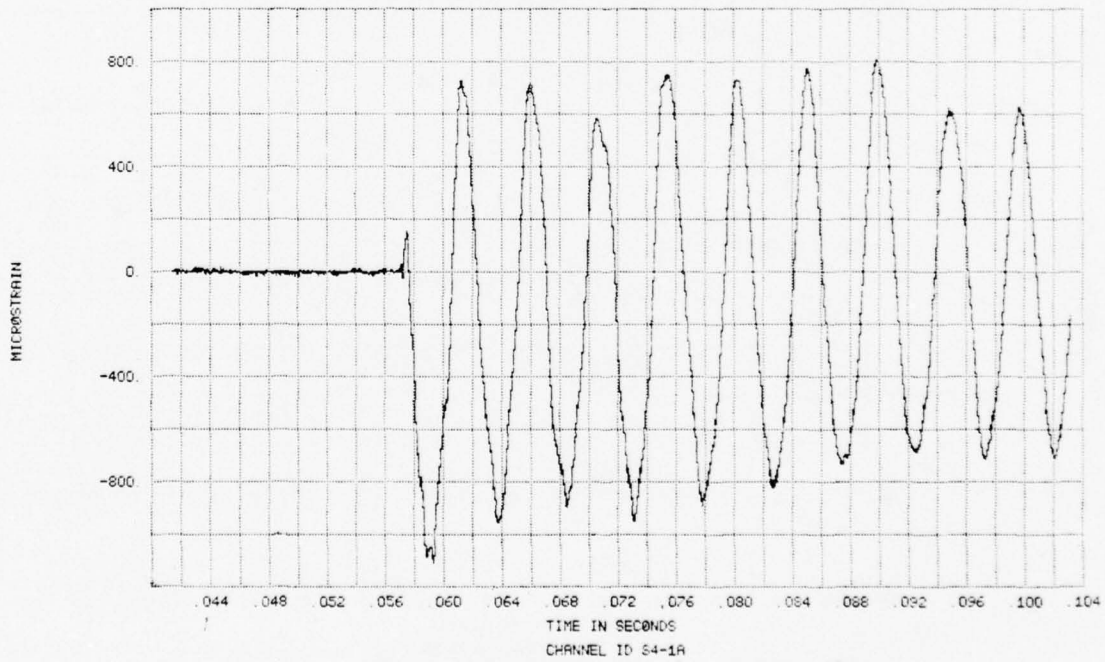


FIGURE 4-163 , SPECIMEN NO. 4 , SHOT NO. 12 ,
STRAIN TIME HISTORY

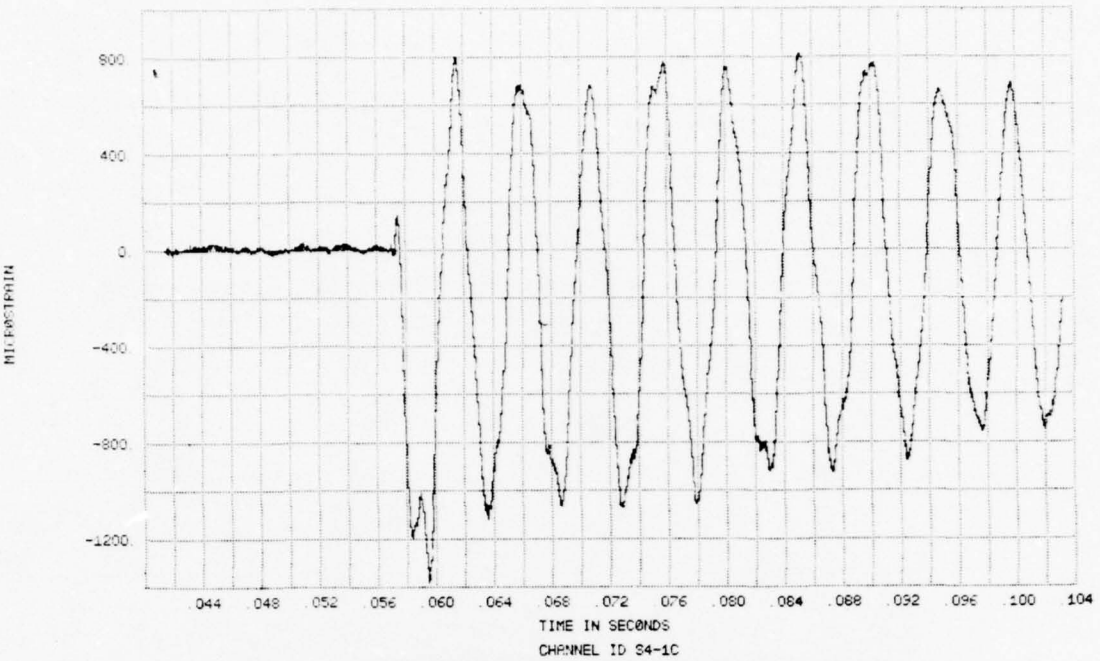


FIGURE 4-164 , SPECIMEN NO. 4 , SHOT NO. 12 ,
STRAIN TIME HISTORY

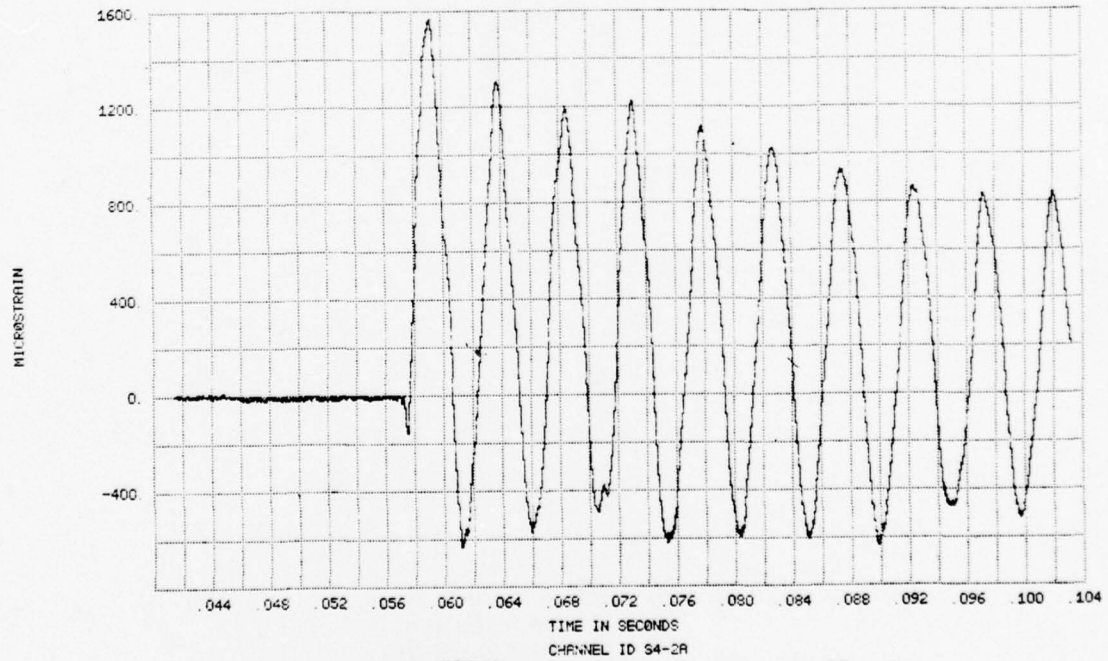


FIGURE 4-165 , SPECIMEN NO. 4 , SHOT NO. 12 ,
STRAIN TIME HISTORY

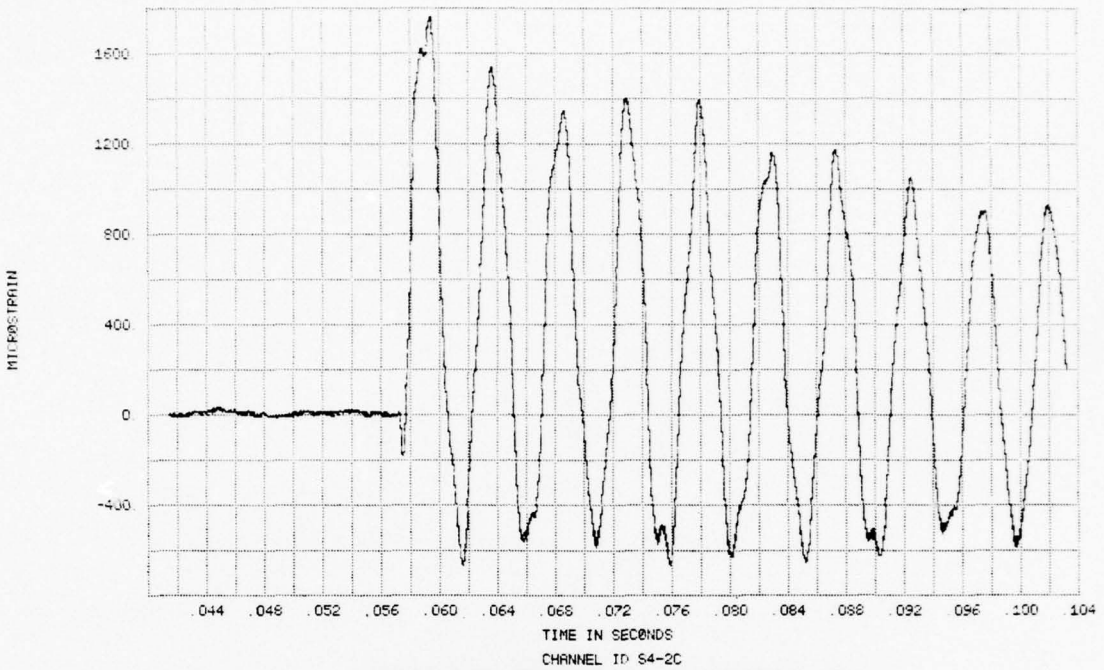


FIGURE 4-166 , SPECIMEN NO. 4 , SHOT NO. 12 , STRAIN TIME HISTORY

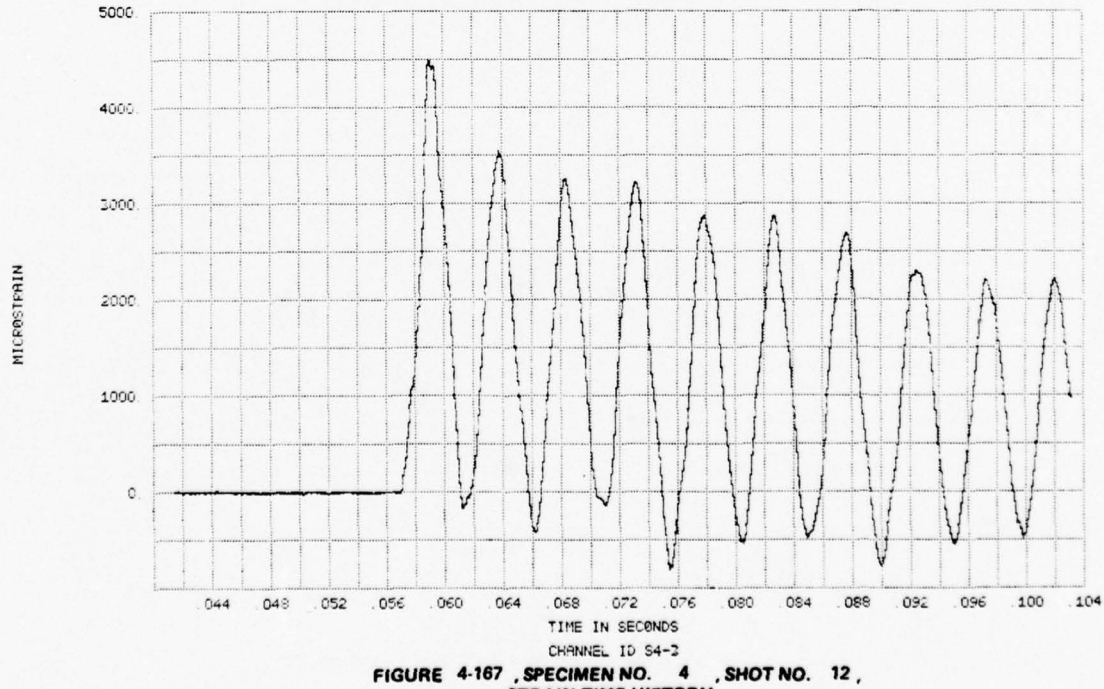


FIGURE 4-167 , SPECIMEN NO. 4 , SHOT NO. 12 , STRAIN TIME HISTORY

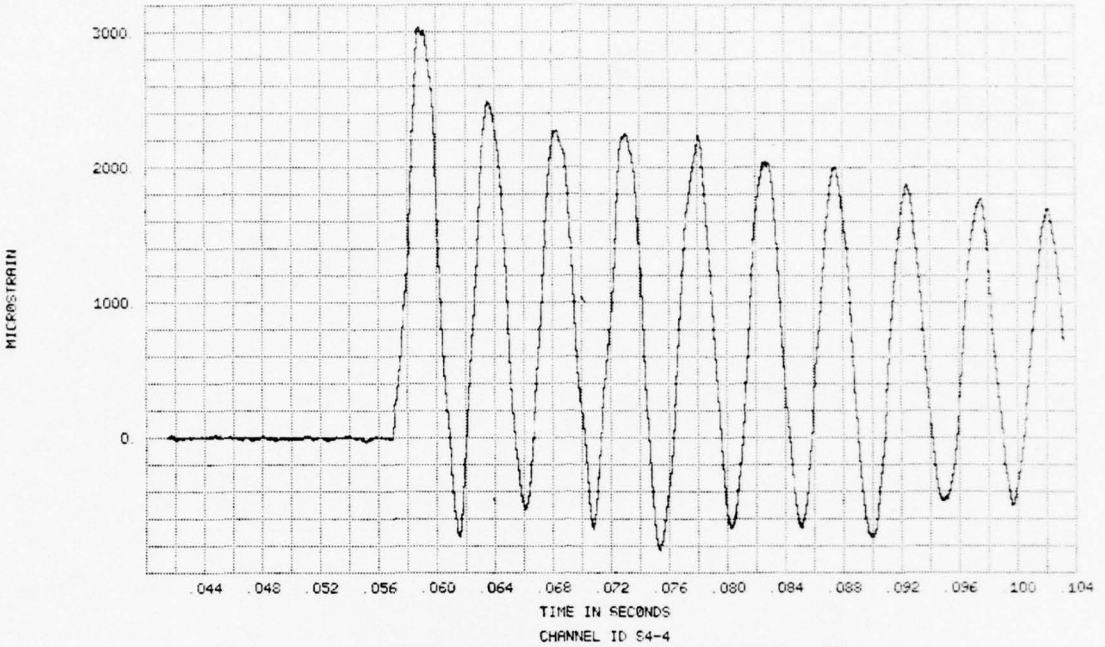


FIGURE 4-168 , SPECIMEN NO. 4 , SHOT NO. 12 , STRAIN TIME HISTORY

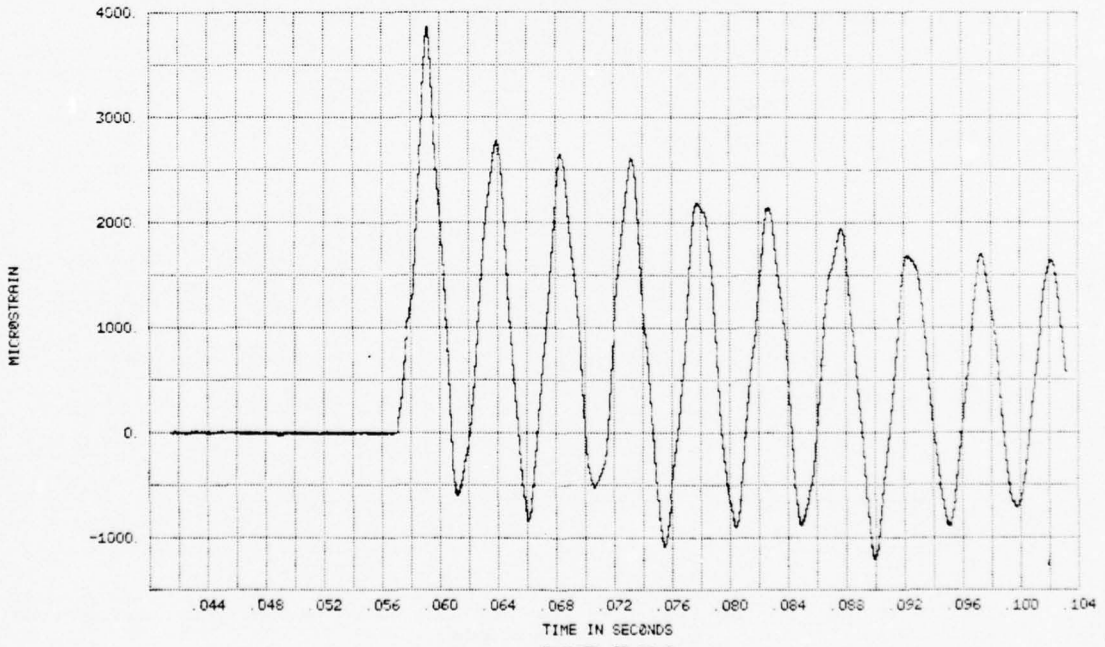


FIGURE 4-169 , SPECIMEN NO. 4 , SHOT NO. 12 , STRAIN TIME HISTORY

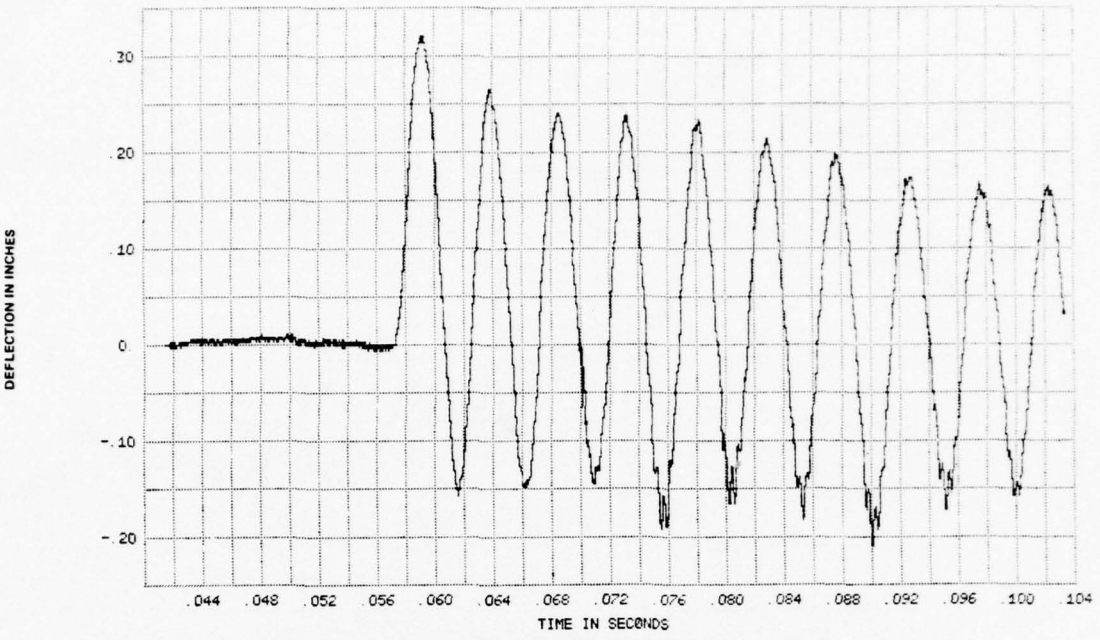


FIGURE 4-170 , SPECIMEN NO. 4 , SHOT NO. 12 ,
DEFLECTION TIME HISTORY

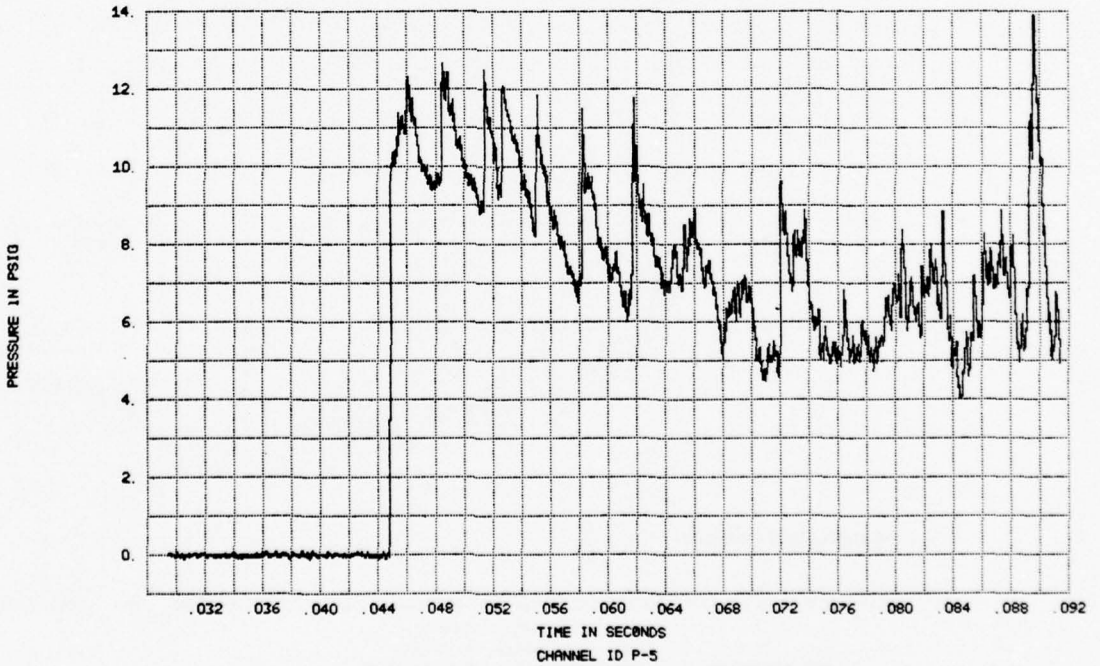


FIGURE 4-171 , SPECIMEN NO. 4 , SHOT NO. 13 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

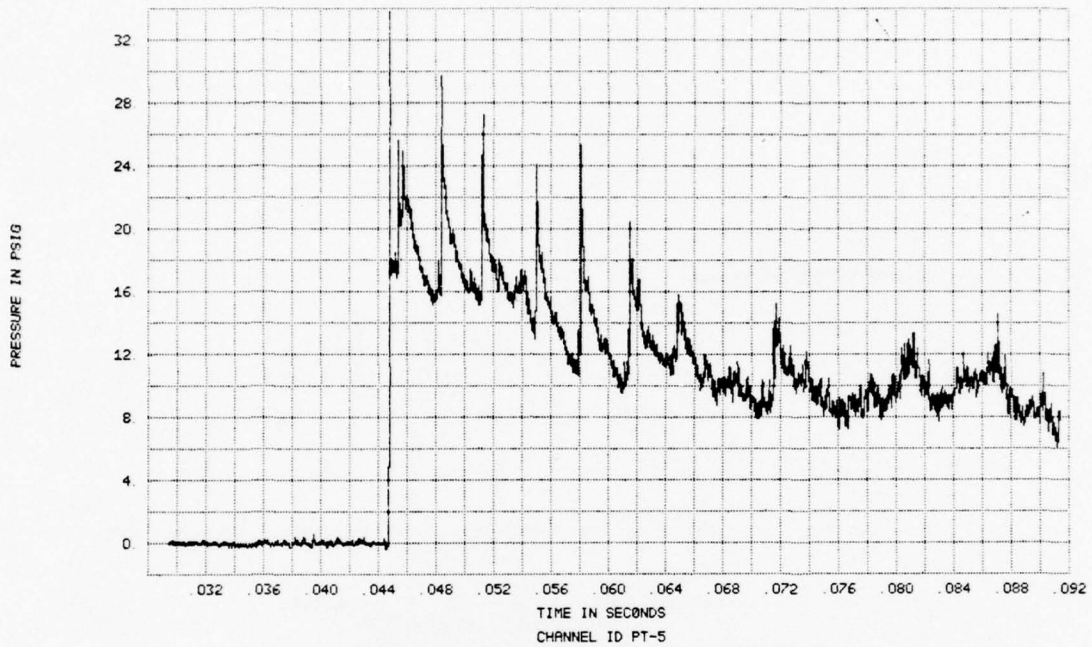


FIGURE 4-172 , SPECIMEN NO. 4 , SHOT NO. 13 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

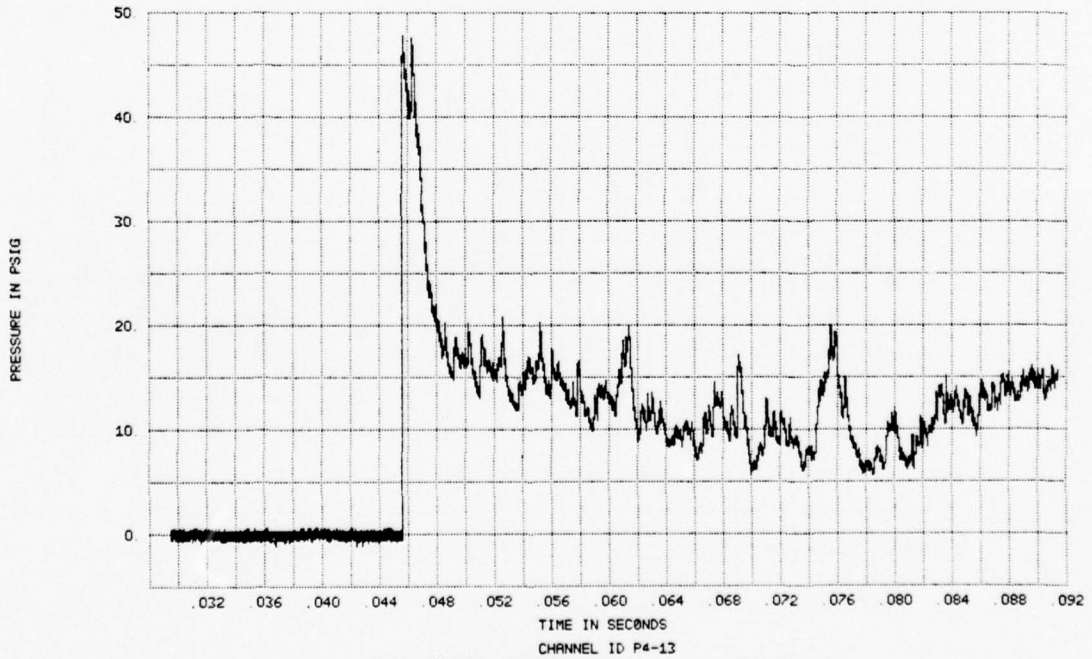


FIGURE 4-173 , SPECIMEN NO. 4 , SHOT NO. 13
SPECIMEN REFLECTED PRESSURE TIME HISTORY

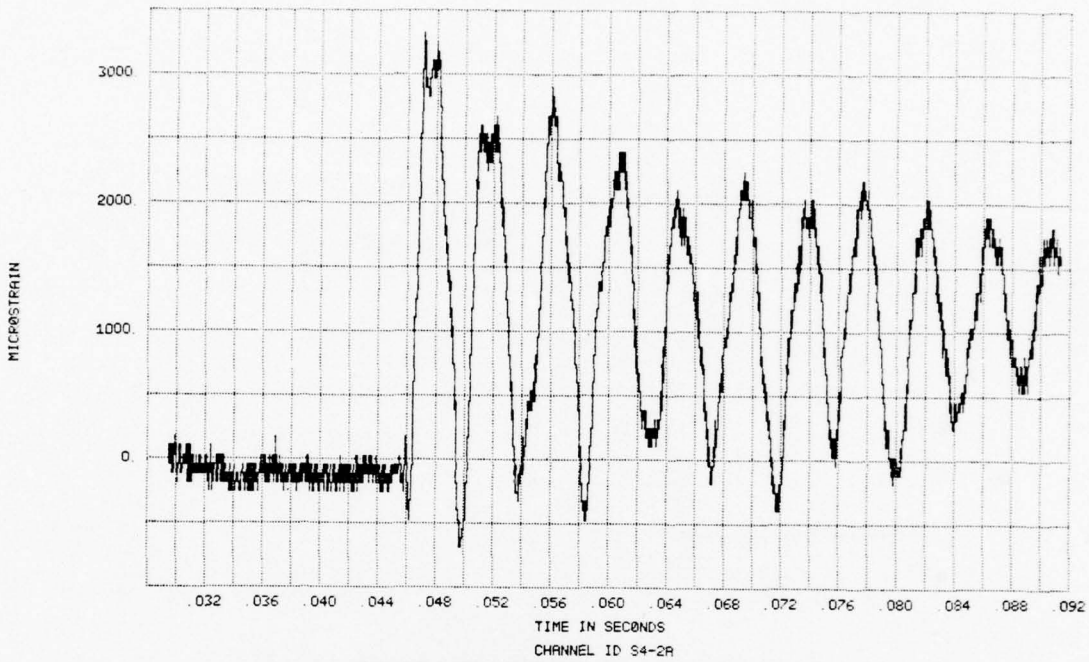


FIGURE 4-174 , SPECIMEN NO. 4 , SHOT NO. 13 , STRAIN TIME HISTORY

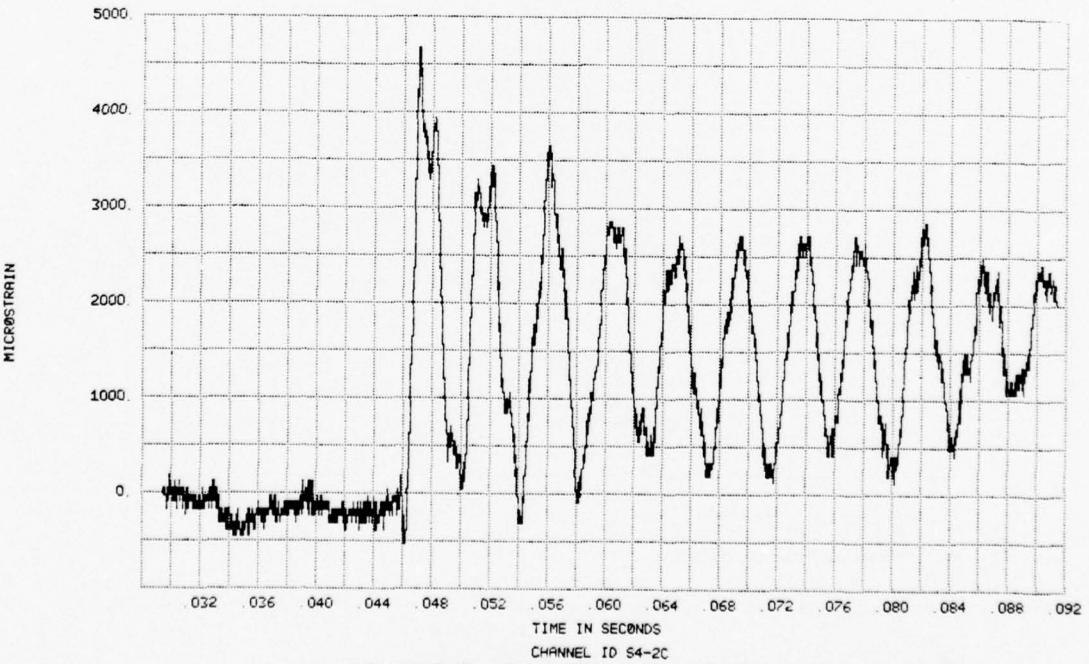


FIGURE 4-175 , SPECIMEN NO. 4 , SHOT NO. 13 , STRAIN TIME HISTORY

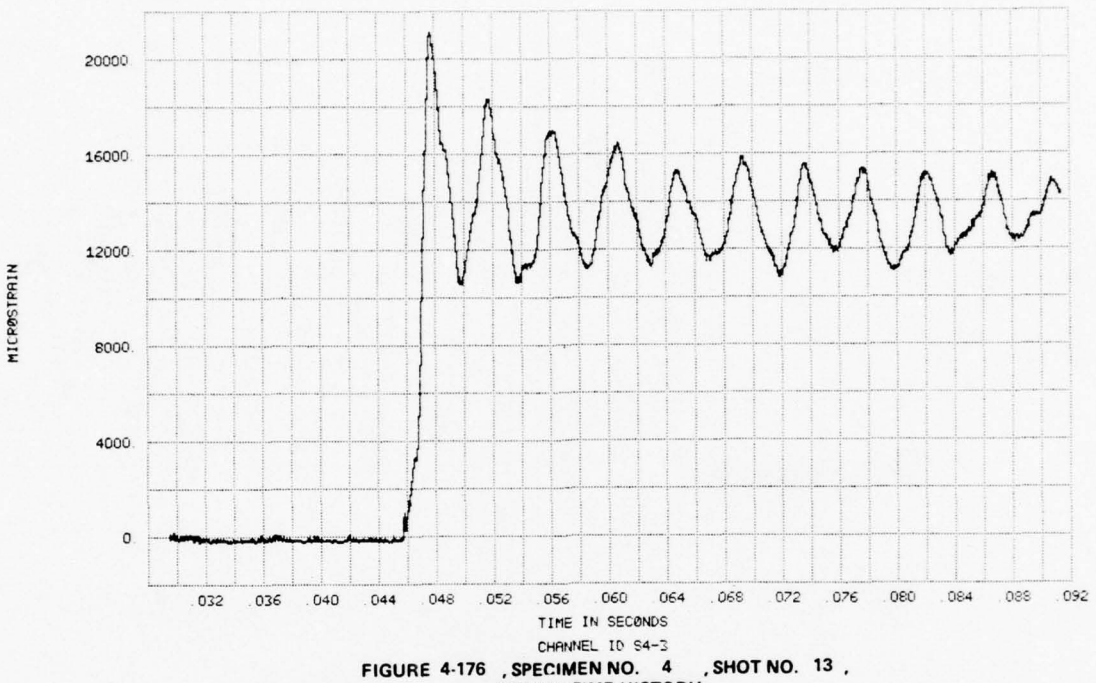


FIGURE 4-176 , SPECIMEN NO. 4 , SHOT NO. 13 ,
STRAIN TIME HISTORY

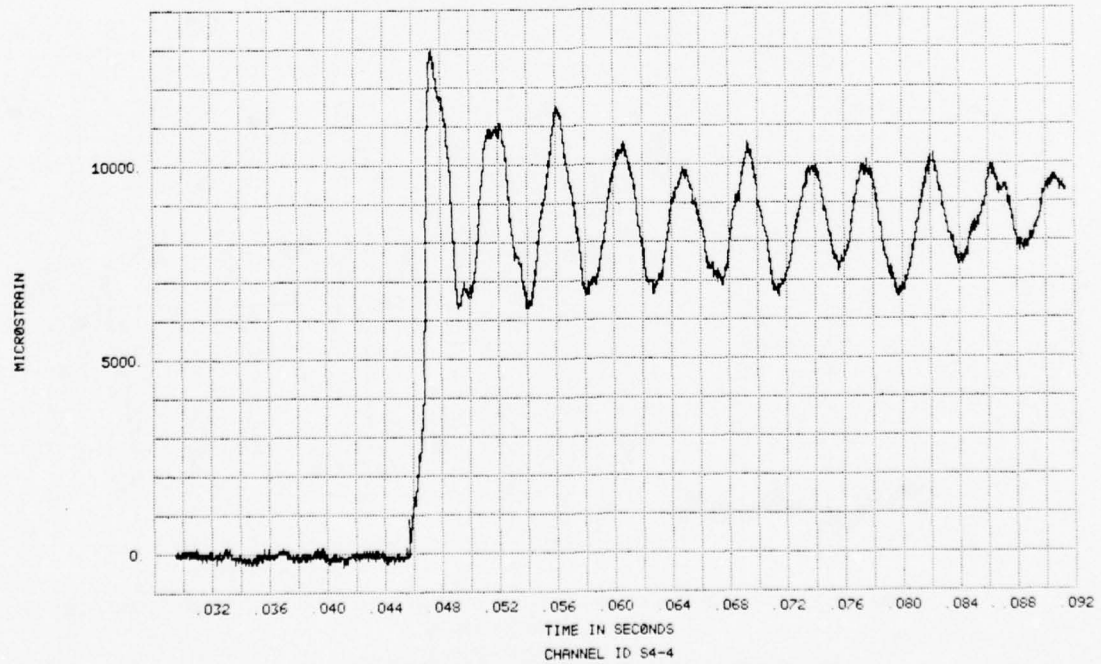


FIGURE 4-177 , SPECIMEN NO. 4 , SHOT NO. 13 ,
STRAIN TIME HISTORY

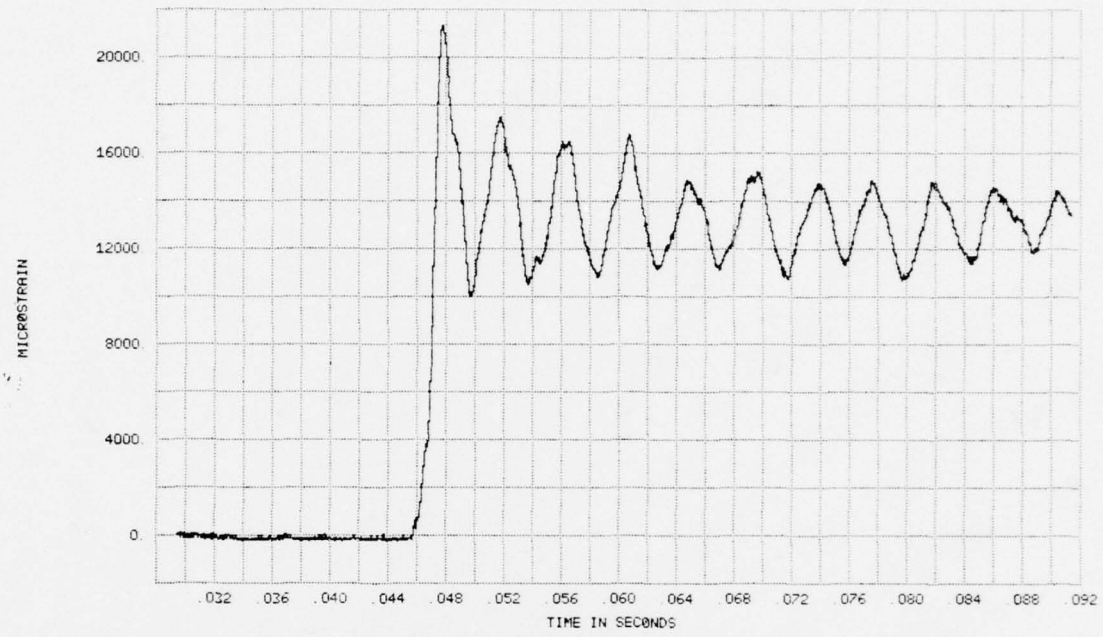


FIGURE 4-178 , SPECIMEN NO. 4 , SHOT NO. 13 , STRAIN TIME HISTORY

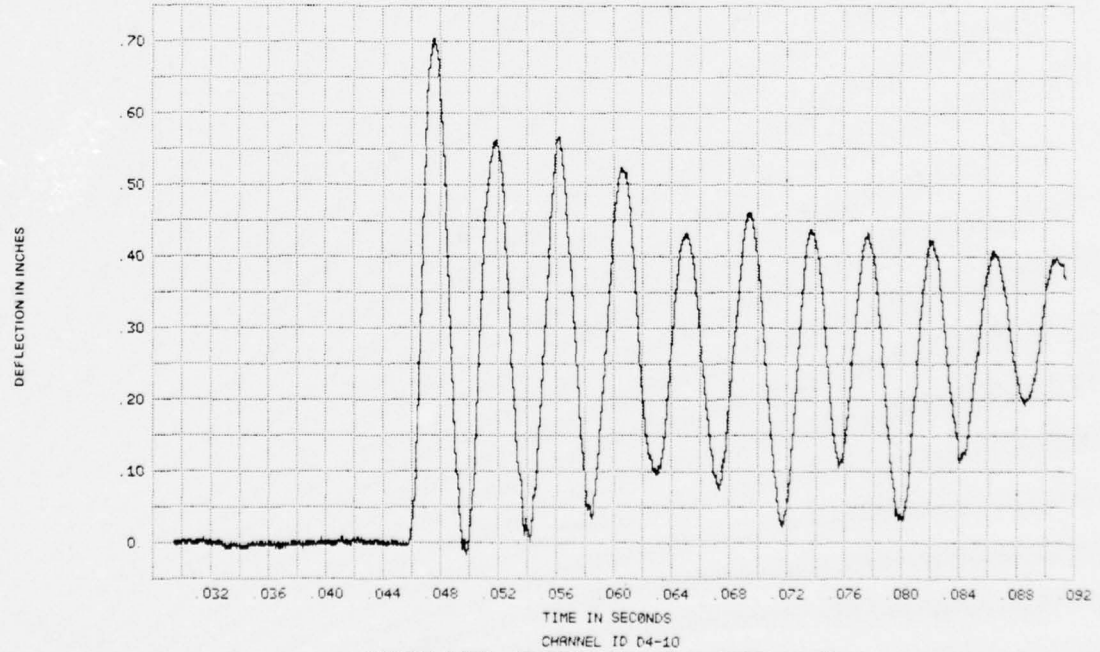
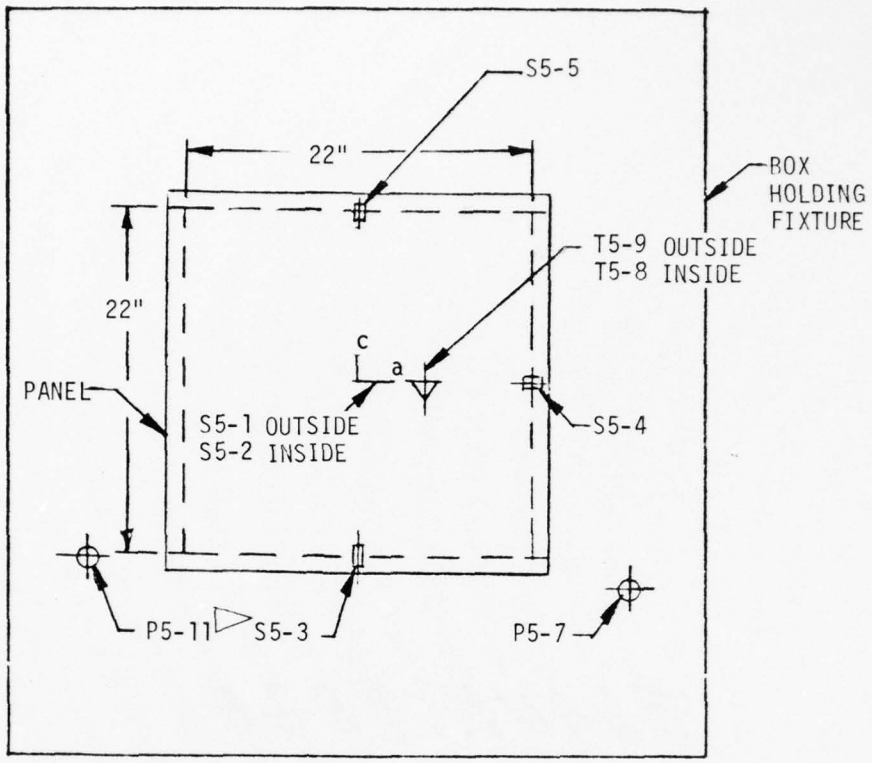


FIGURE 4-179 , SPECIMEN NO. 4 , SHOT NO. 13 , DEFLECTION TIME HISTORY



SPECIMEN NO. 5

FLAT UNSTIFFENED PANEL

FOUR SIDES CLAMPED

MATERIAL - 6061-T6 ALUMINUM ALLOY

DENSITY - .0002539 lb-sec^2/in^4 (MIL-HDBK-5)

POISSON'S RATIO - .33

MODULUS OF ELASTICITY - 10.1 x 10^6 PSI

SHEAR MODULUS - 3.8 x 10^6 PSI

% ELONGATION - 12.0

F_{ty} - 41,180 PSI

F_{tu} - 46,760 PSI

THICKNESS - .020 IN.

▷ ON BACK SIDE OF BOX HOLDING FIXTURE ONLY



Figure 5-1 - SPECIMEN NO. 5 - INSTRUMENTATION - FRONT

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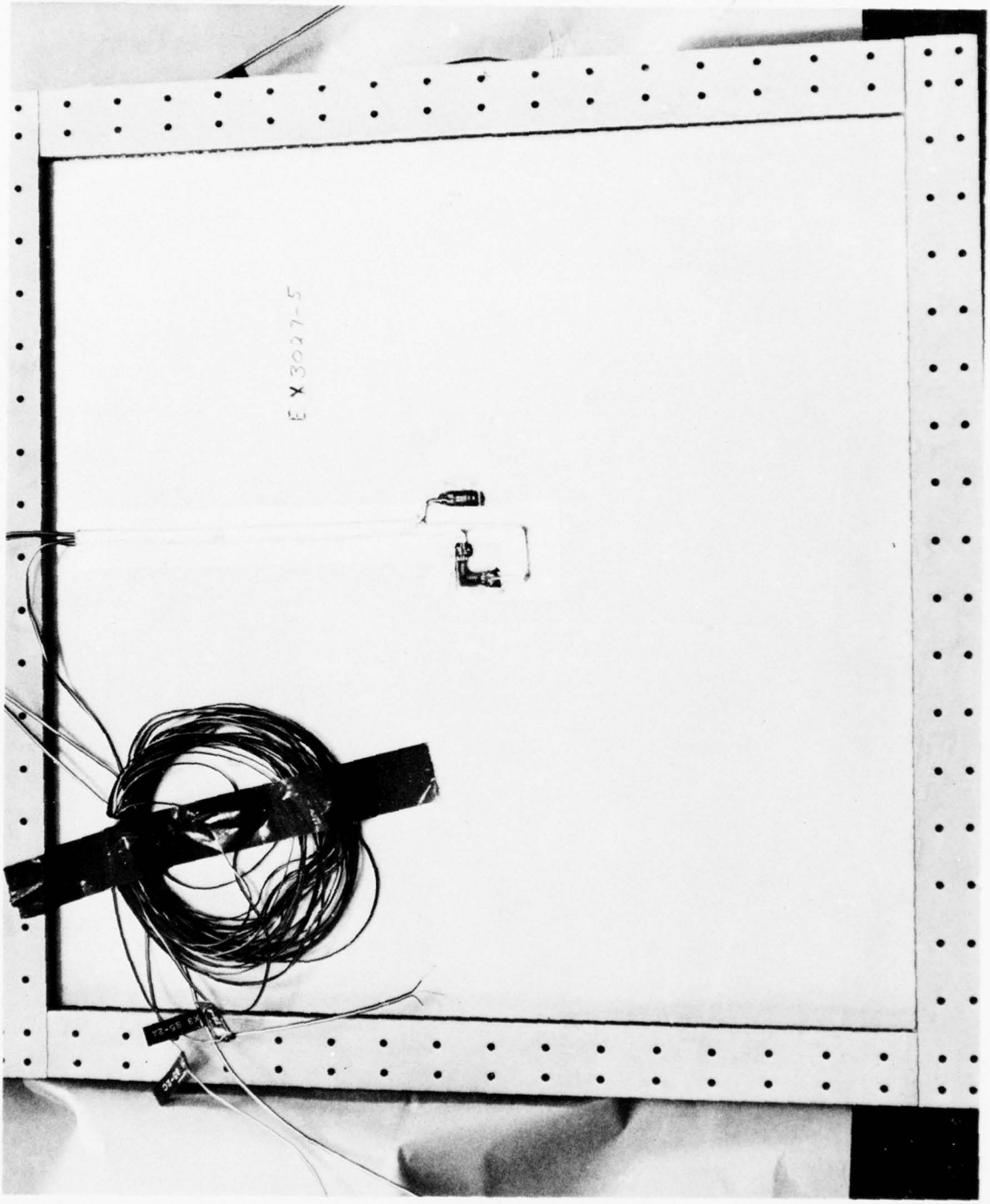


FIGURE 5-2 - SPECIMEN NO. 5 - INSTRUMENTATION - BACK

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.5 - STATIC ANALYSIS - PRESS = 5.0 PSI - MAY'76 - SYRING  GP  1
           1           0                                                  GP  2
0.0         0.1         0.01        0.0                                   GP  3
0.0         0.0         0.0         0.0                                   GP  4
          15          15                                                  GP  5
100000.                                                                   GP  7
                                                                          GP  8
           2           0                                                  GP  9
           2                                                              GP 10
           0           0                                                  GP 12
           0           0                                                  GP 15
           2           2                                                  GP 18
0.0         0.0                                                           GP 19
0.0         42.0                                                          GP 19
-42.0       0.0                                                           GP 20
-42.0       42.0                                                          GP 20
           0                                                              GP 21
           4           1           1                                      GP 25
-21.0       0.0         21.0                                              GP 26
-5.0                                                                      GP 30
           7           7          15          15                         GPP  1
           0           1           1                                     GPP  2
          24                                                              GPP  3
           3           4                                                  GPP  4
           3           5                                                  GPP  4
           3           6                                                  GPP  4
           3           7                                                  GPP  4
           4           3                                                  GPP  4
           4           4                                                  GPP  4
           4           5                                                  GPP  4
           4           6                                                  GPP  4
           4           7                                                  GPP  4
           5           3                                                  GPP  4
           5           4                                                  GPP  4
           5           5                                                  GPP  4
           5           6                                                  GPP  4
           5           7                                                  GPP  4
           6           3                                                  GPP  4
           6           4                                                  GPP  4
           6           5                                                  GPP  4
           6           6                                                  GPP  4
           6           7                                                  GPP  4
           7           3                                                  GPP  4
           7           4                                                  GPP  4
           7           5                                                  GPP  4
           7           6                                                  GPP  4
           7           7                                                  GPP  4
           1                                                              GPP  5
22.0        22.0                                                          GPP  6
0.02        .0002539                                                      GPP  7
10100000.   10100000.   0.33        0.33        3800000.                  GPP  8
41180.      41180.                                                        GPP  9
0.0         0.0         0.0         0.0         0.0         0.0           GPP 13
0.0         0.0         0.0         0.0         0.0         0.0           GPP 13
0.0         0.0         0.0         0.0         0.0         0.0           GPP 13
0.0         0.0         0.0         0.0         0.0         0.0           GPP 13
0.0         0.0         0.0         0.0         0.0         0.0           GPP 13
0.0         0.0         0.0         0.0         0.0         0.0           GPP 13
0.0         0.0         0.0         0.0         0.0         0.0           GPP 13
0.0         0.0         0.0         0.0         0.0         0.0           GPP 13
0.0                                                                       GPP 13
.000001     .000001     1.0                                               GPP 14
                                                                          GP  32
```

TABLE XXIX

STATIC TEST STRESSES - SPECIMEN NO. 5
(STRESSES GIVEN IN PSI)

STRAIN GAUGE	STATIC PRESSURE (PSI)		
	1.6	3.2	4.0
S5-1	6584.	11545.	13663.
S5-2	8073.	13381.	15730.
S5-3	15517.	25956.	30976.
S5-4	18520.	30206.	36190.
S5-5	20424.	33323.	39930.

TABLE XXX

STATIC TEST DISPLACEMENTS - SPECIMEN NO. 5
(DISPLACEMENT MEASURED AT CENTER OF PANEL

	STATIC PRESSURE (PSI)		
	1.6	3.2	4.0
DISPLACEMENT (INCHES)	.338	.435	.472

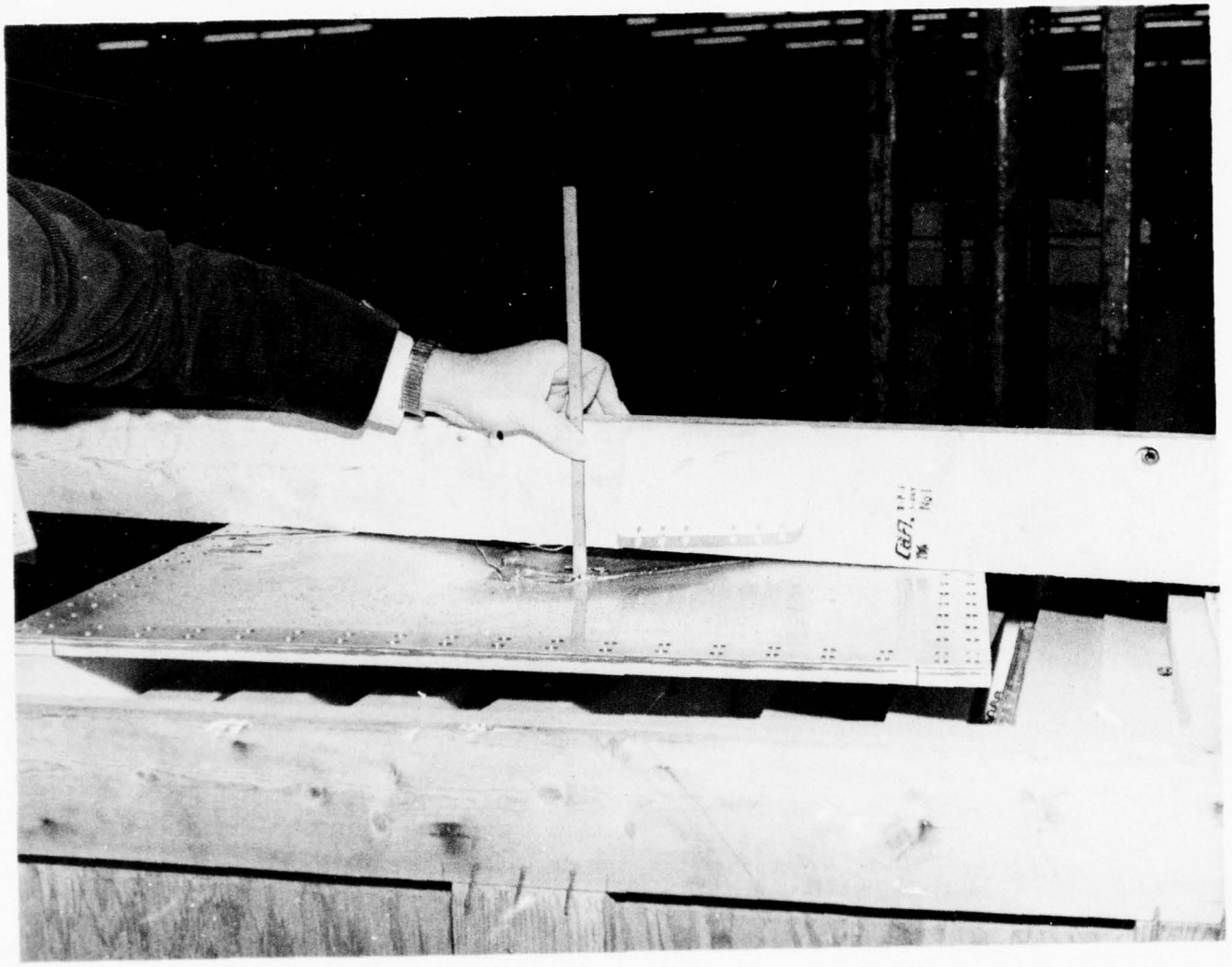


FIGURE 5-3 - SPECIMEN NO. 5 - INDICATION OF SHOCK TEST PERMANENT DEFORMATION

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.5 -DYNAMIC ANALYSIS - ITERATIVE TPD SOLUTION                    GP  1
          1           0                                                          GP  2
5000.      0.001       0.02        0.0                                         GP  3
0.0        0.0         0.0         0.0                                         GP  4
         15          15                                                         GP  5
600.0                                                                           GP  7
                                                                                GP  8
          2           0                                                         GP  9
          0           1                                                         GP 10
0.5                                                                             GP 11
          0           0                                                         GP 12
          0           0                                                         GP 15
          2           2                                                         GP 18
48.0       0.0                                                                  GP 19
20.0      96.0                                                                  GP 19
-60.0      0.0                                                                  GP 20
-70.0     96.0                                                                  GP 20
          0                                                                     GP 21
          4           1           1                                             GP 25
-21.0      0.0        21.0                                                      GP 26
                                                                                GP 30
          7           7          15          15                                GPP  1
          0           1           1                                            GPP  2
         24                                                                     GPP  3
          3           4                                                         GPP  4
          3           5                                                         GPP  4
          3           6                                                         GPP  4
          3           7                                                         GPP  4
          4           3                                                         GPP  4
          4           4                                                         GPP  4
          4           5                                                         GPP  4
          4           6                                                         GPP  4
          4           7                                                         GPP  4
          5           3                                                         GPP  4
          5           4                                                         GPP  4
          5           5                                                         GPP  4
          5           6                                                         GPP  4
          5           7                                                         GPP  4
          6           3                                                         GPP  4
          6           4                                                         GPP  4
          6           5                                                         GPP  4
          6           6                                                         GPP  4
          6           7                                                         GPP  4
          7           3                                                         GPP  4
          7           4                                                         GPP  4
          7           5                                                         GPP  4
          7           6                                                         GPP  4
          7           7                                                         GPP  4
          1                                                                     GPP  5
22.0      22.0                                                                  GPP  6
0.02      .0002539                                                              GPP  7
10100000. 10100000.   0.33        0.33        3800000.                        GPP  8
41180.    41180.                                                              GPP  9
0.0       0.0         0.0         0.0         0.0         0.0                 GPP 13
0.0       0.0         0.0         0.0         0.0         0.0                 GPP 13
0.0       0.0         0.0         0.0         0.0         0.0                 GPP 13
0.0       0.0         0.0         0.0         0.0         0.0                 GPP 13
0.0       0.0         0.0         0.0         0.0         0.0                 GPP 13
0.0       0.0         0.0         0.0         0.0         0.0                 GPP 13
0.0       0.0         0.0         0.0         0.0         0.0                 GPP 13
0.0       0.0         0.0         0.0         0.0         0.0                 GPP 13
0.0                                                                             GPP 13
0.0       0.010      25.0                                                      GPP 14
                                                                                GP 32
```

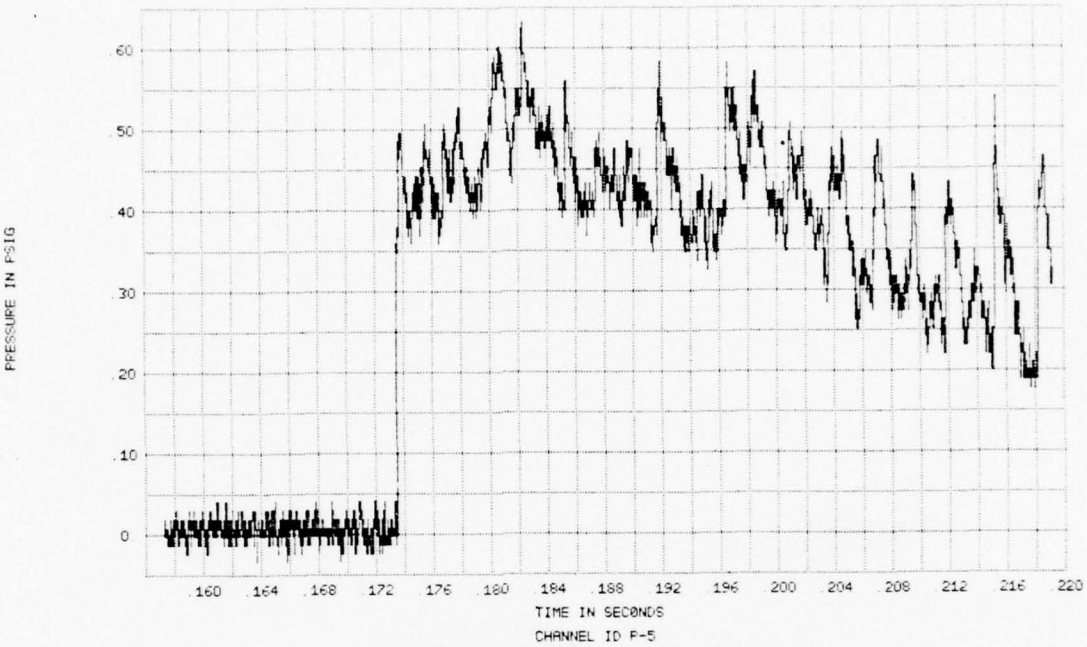


FIGURE 5-6 , SPECIMEN NO. 5 , SHOT NO. 1 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

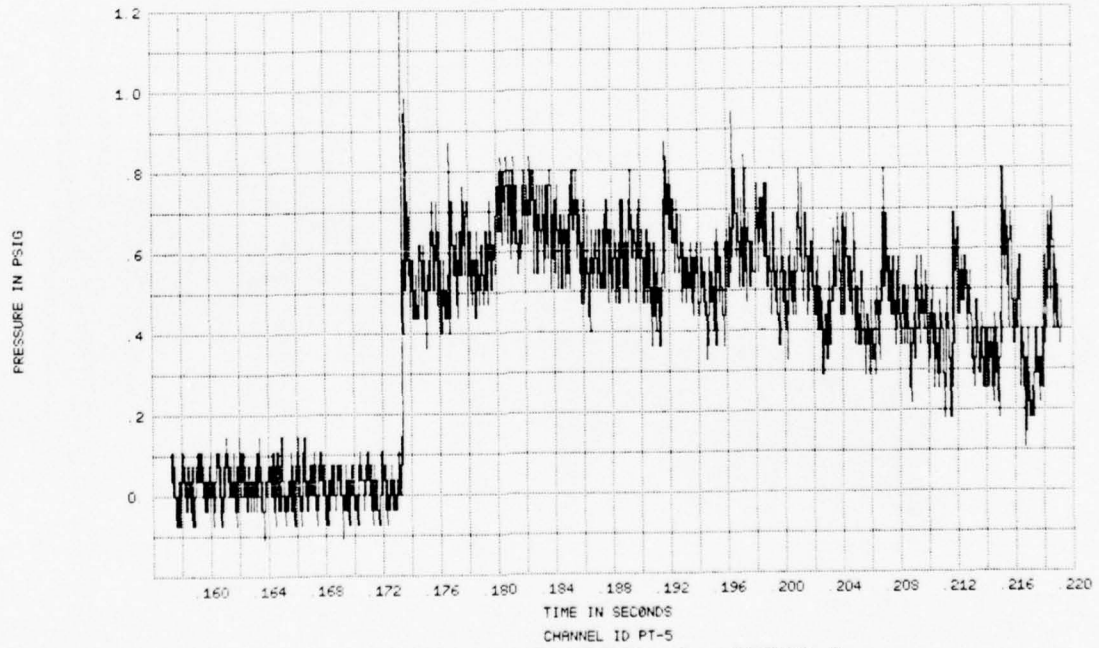


FIGURE 5-7 , SPECIMEN NO. 5 , SHOT NO. 1 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

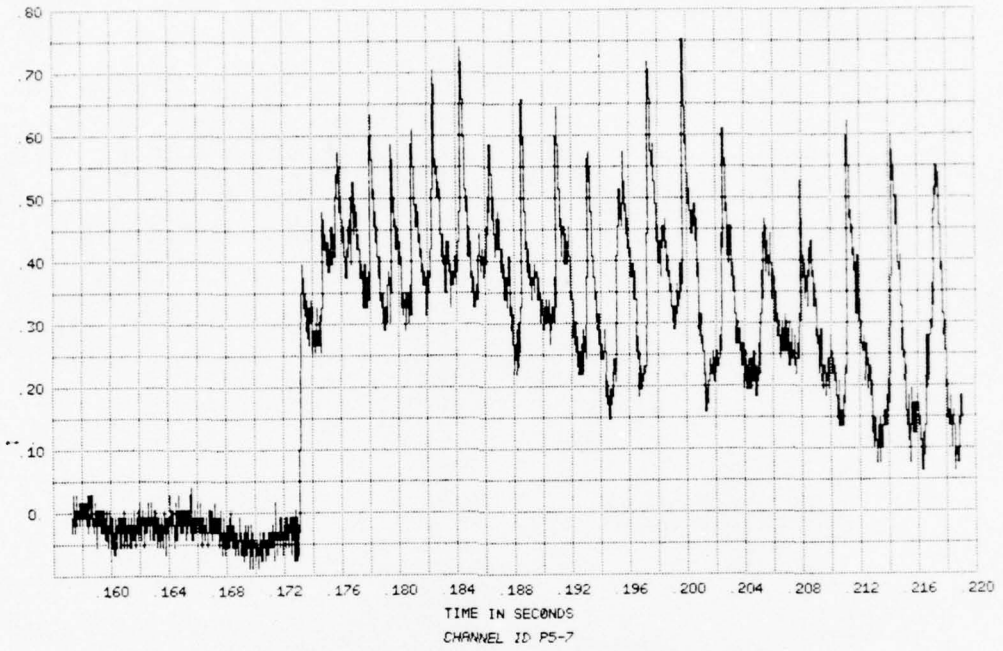


FIGURE 5-8 , SPECIMEN NO. 5 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

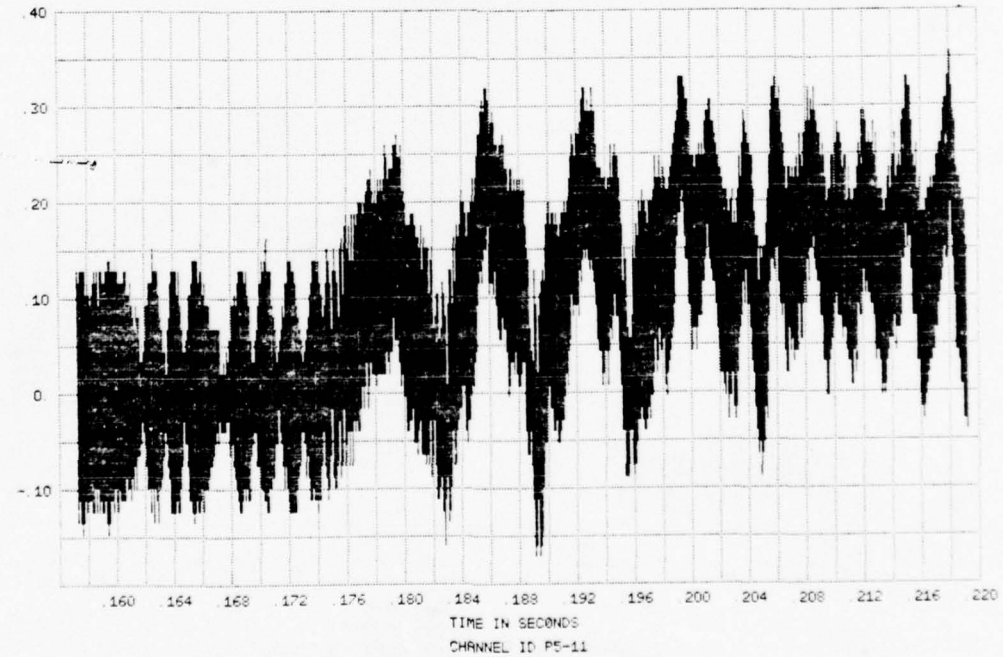


FIGURE 5-9 , SPECIMEN NO. 5 , SHOT NO. 1 ,
INTERNAL PRESSURE TIME HISTORY

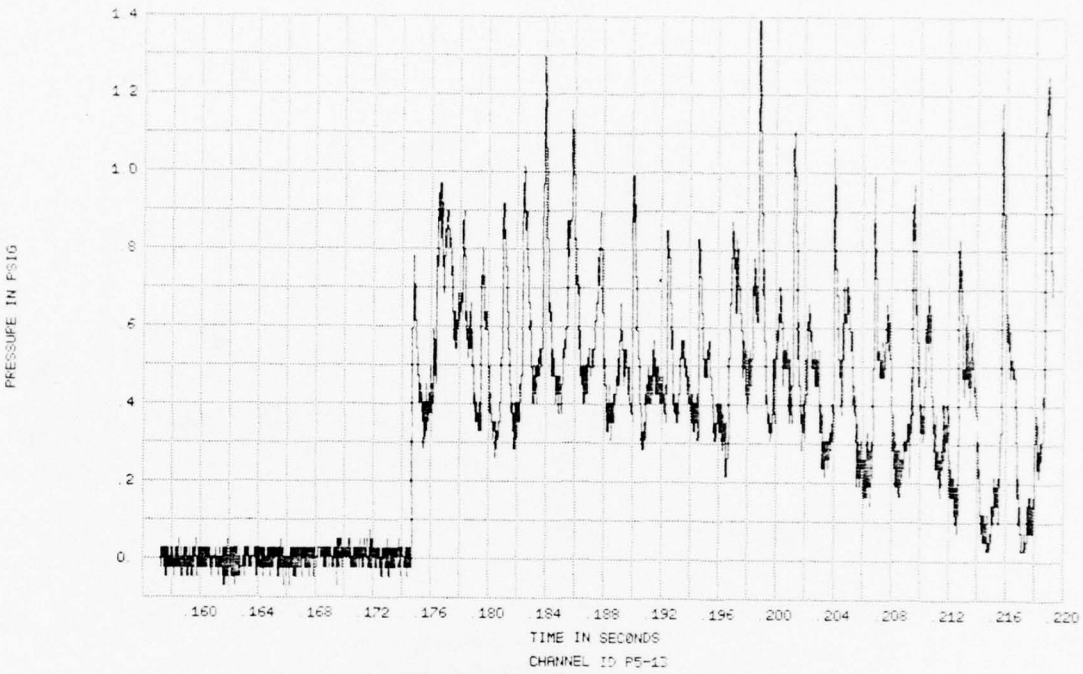


FIGURE 5-10 , SPECIMEN NO. 5 , SHOT NO. 1 , SPECIMEN REFLECTED PRESSURE TIME HISTORY

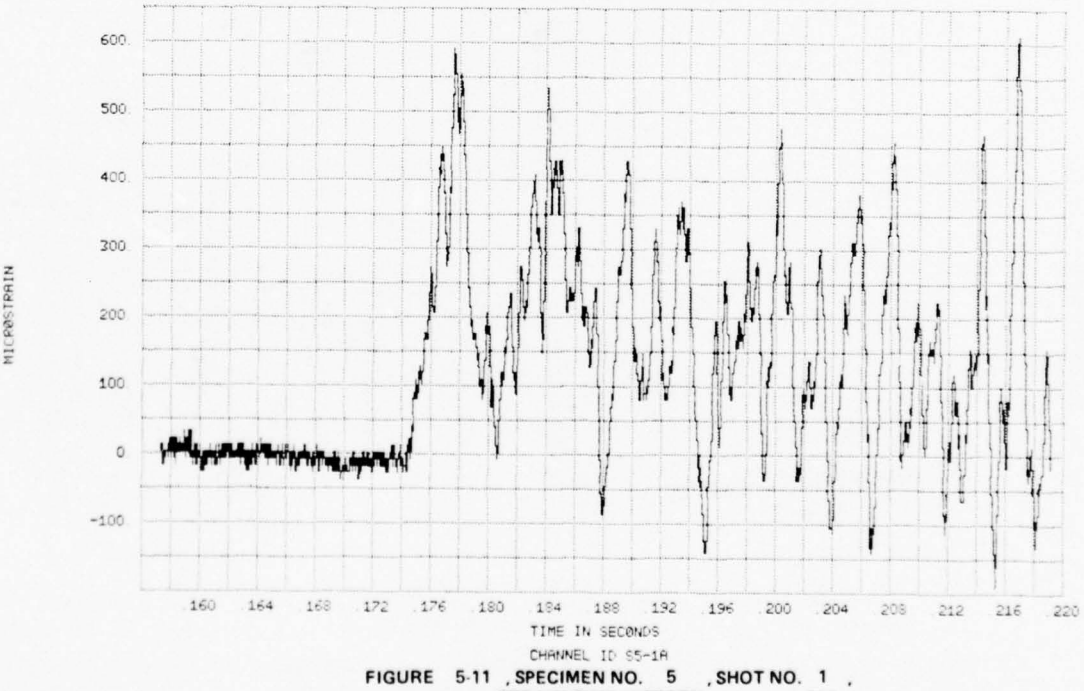


FIGURE 5-11 , SPECIMEN NO. 5 , SHOT NO. 1 , STRAIN TIME HISTORY

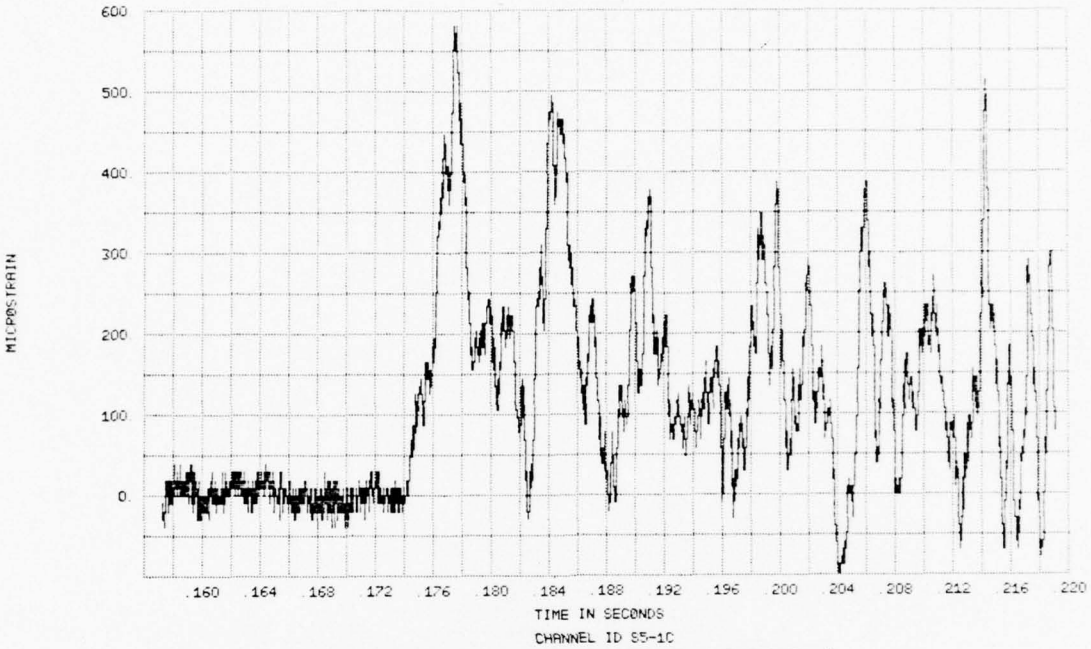


FIGURE 5-12 , SPECIMEN NO. 5 , SHOT NO. 1 ,
STRAIN TIME HISTORY

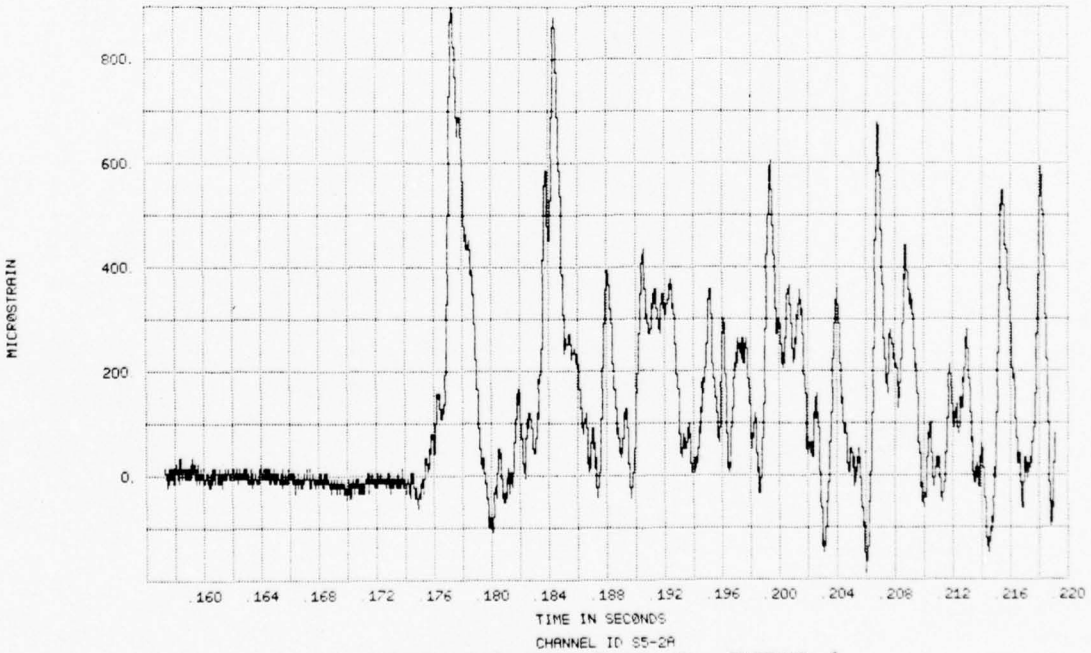


FIGURE 5-13 , SPECIMEN NO. 5 , SHOT NO. 1 ,
STRAIN TIME HISTORY

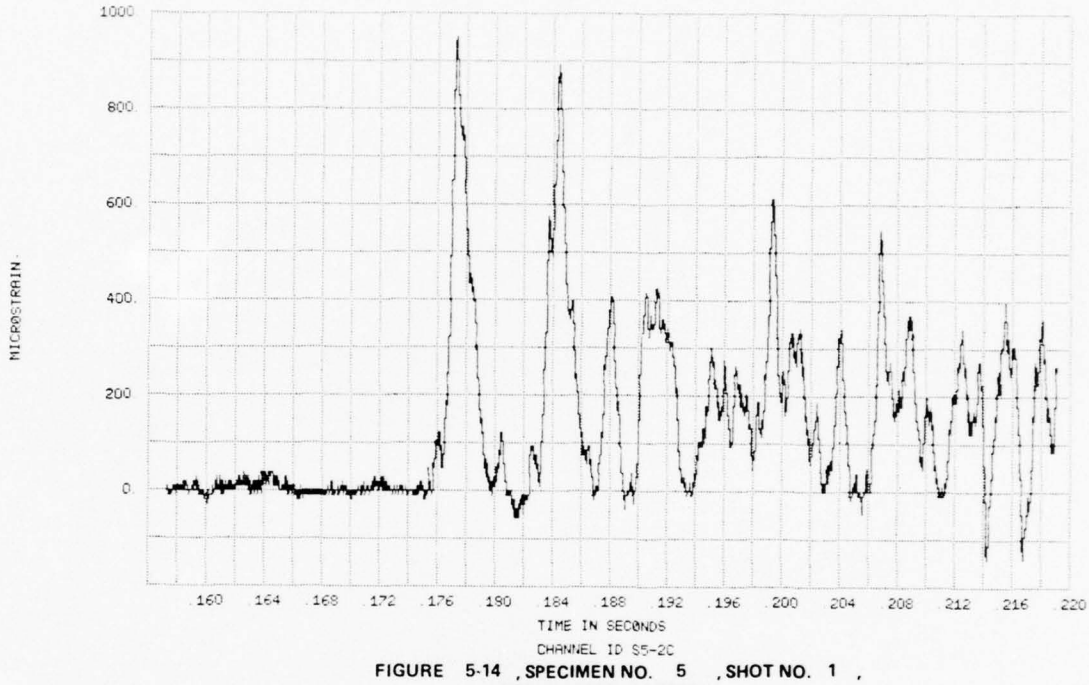


FIGURE 5-14 , SPECIMEN NO. 5 , SHOT NO. 1 ,
STRAIN TIME HISTORY

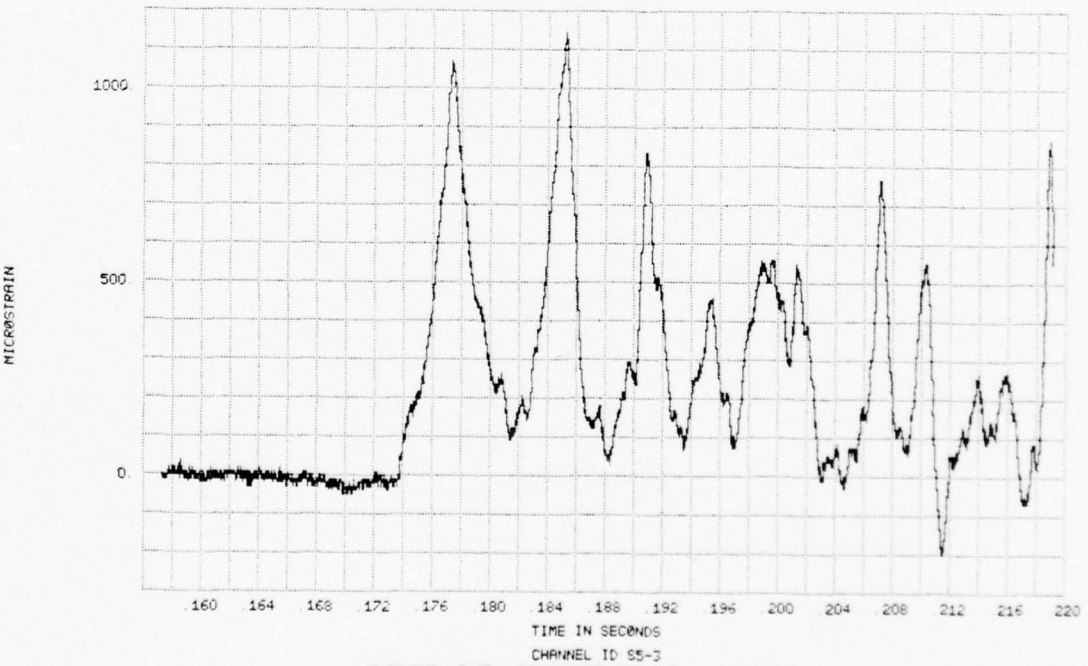


FIGURE 5-15 , SPECIMEN NO. 5 , SHOT NO. 1 ,
STRAIN TIME HISTORY

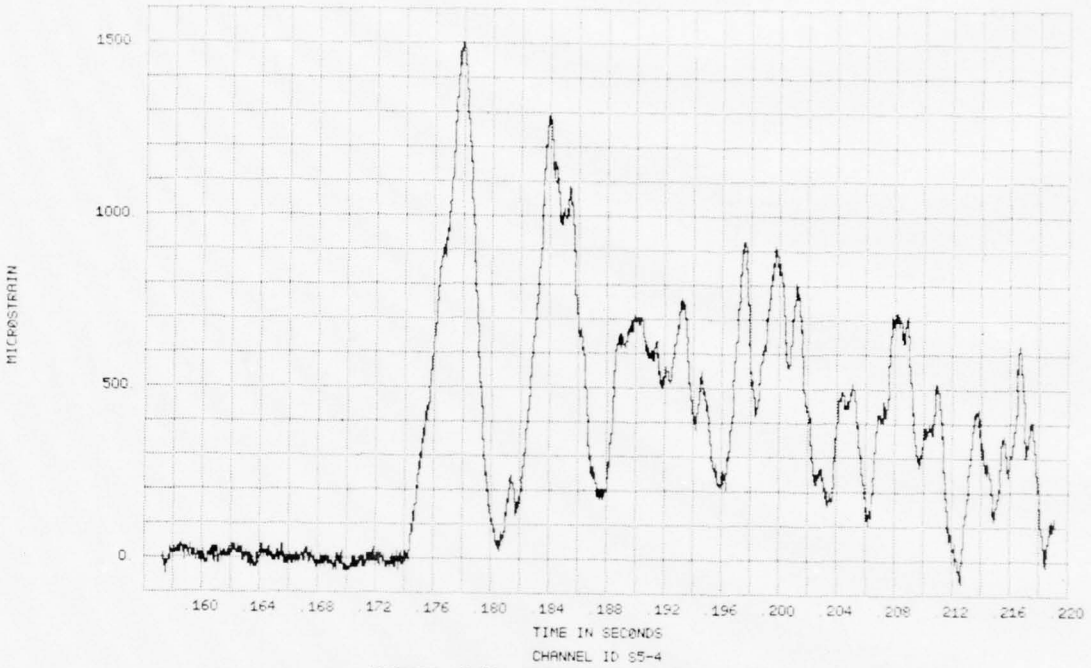


FIGURE 5-16 , SPECIMEN NO. 5 , SHOT NO. 1 ,
STRAIN TIME HISTORY

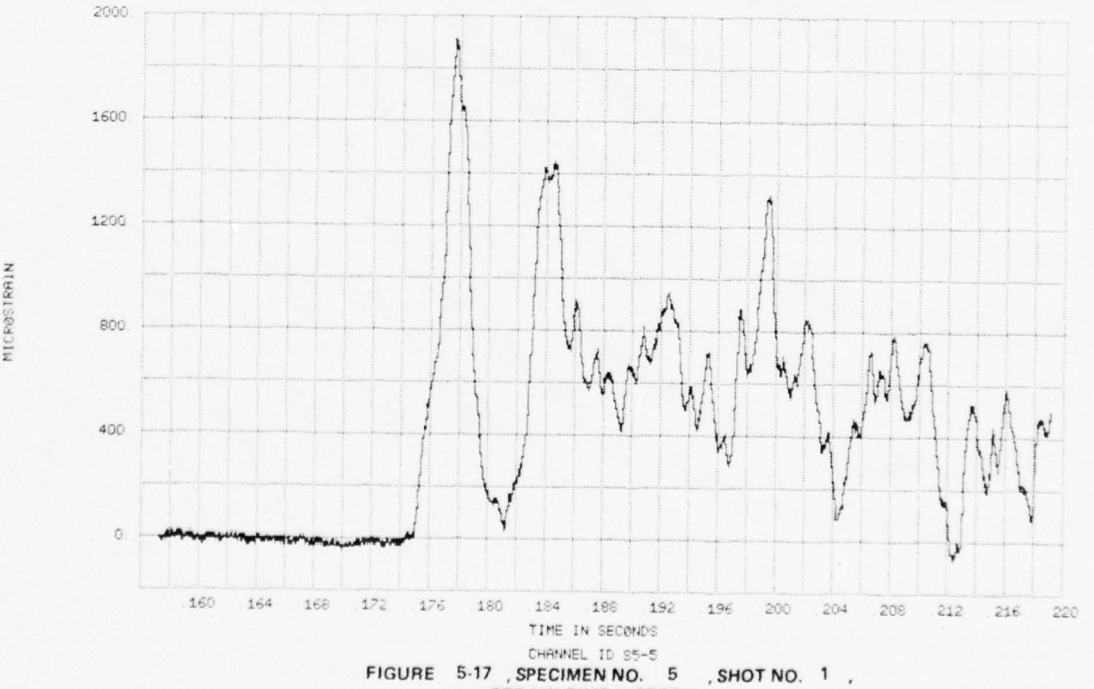


FIGURE 5-17 , SPECIMEN NO. 5 , SHOT NO. 1 ,
STRAIN TIME HISTORY

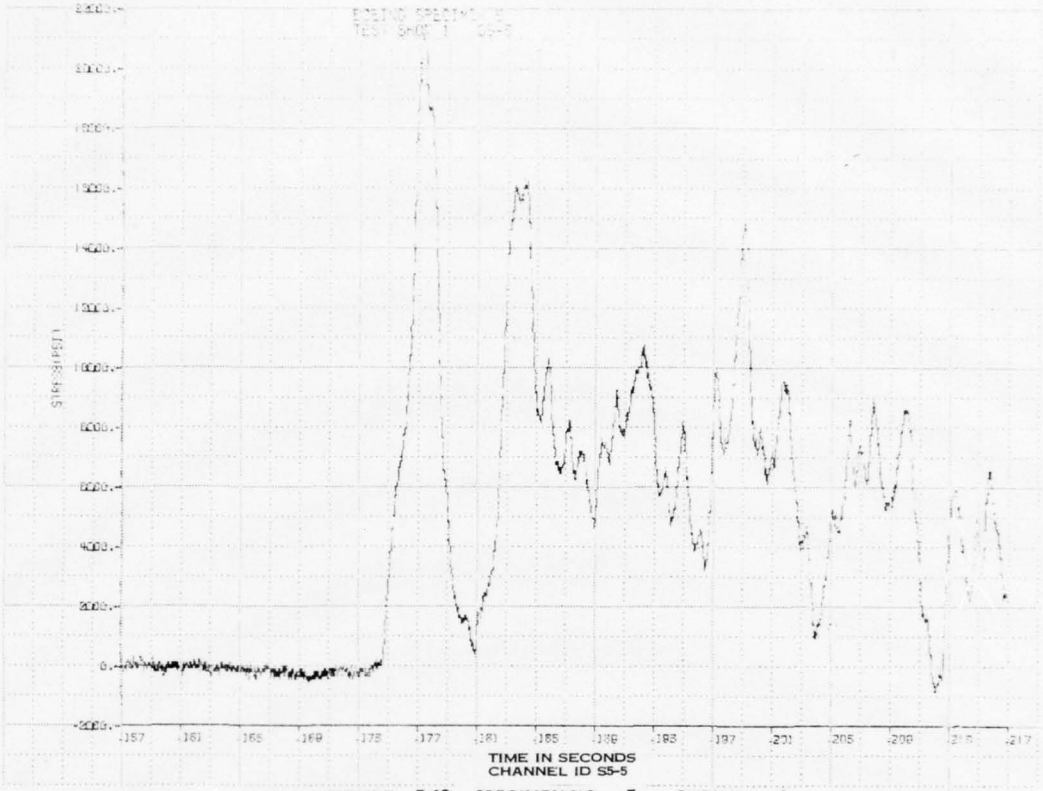


FIGURE 5-18 , SPECIMEN NO. 5 , SHOT NO. 1 ,
STRESS TIME HISTORY

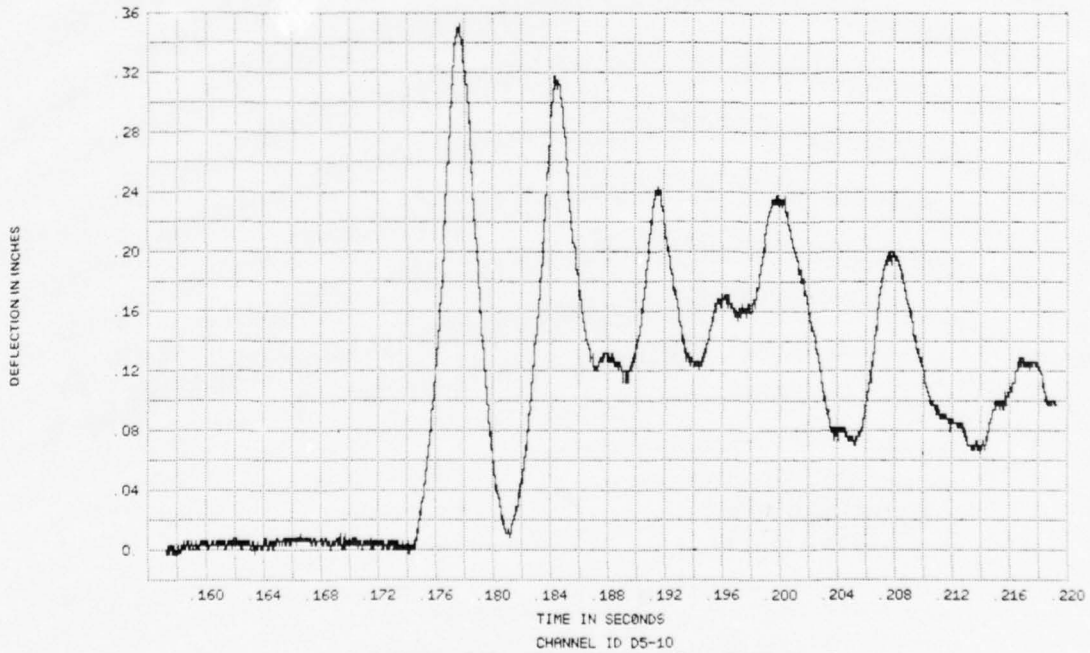


FIGURE 5-19 , SPECIMEN NO. 5 , SHOT NO. 1 ,
DEFLECTION TIME HISTORY

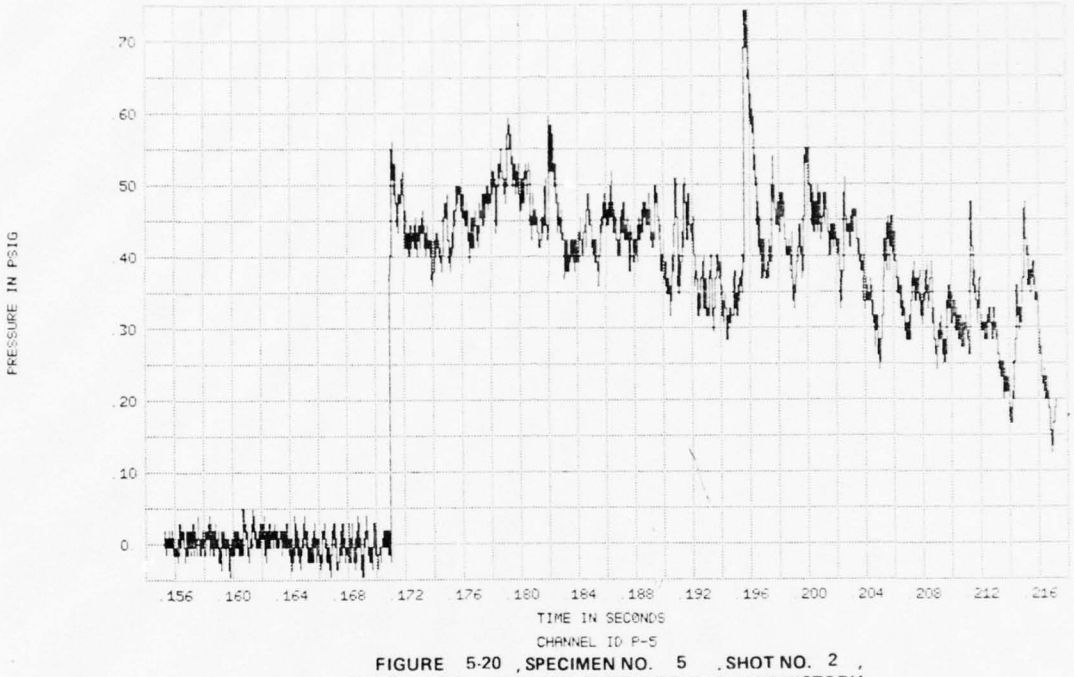


FIGURE 5-20 , SPECIMEN NO. 5 , SHOT NO. 2 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

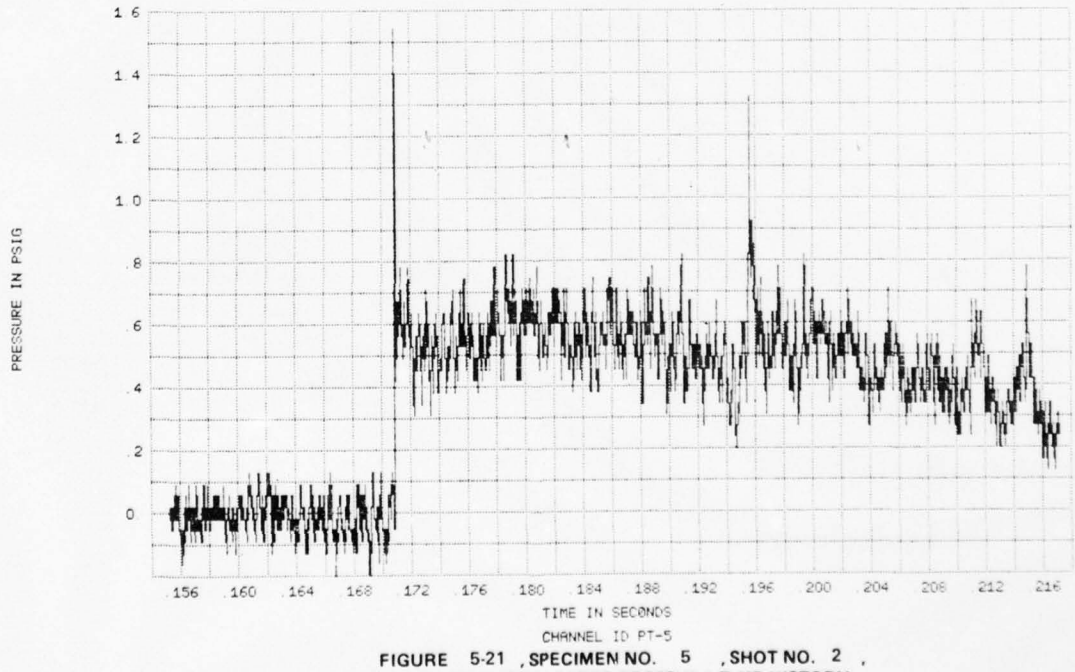


FIGURE 5-21 , SPECIMEN NO. 5 , SHOT NO. 2 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

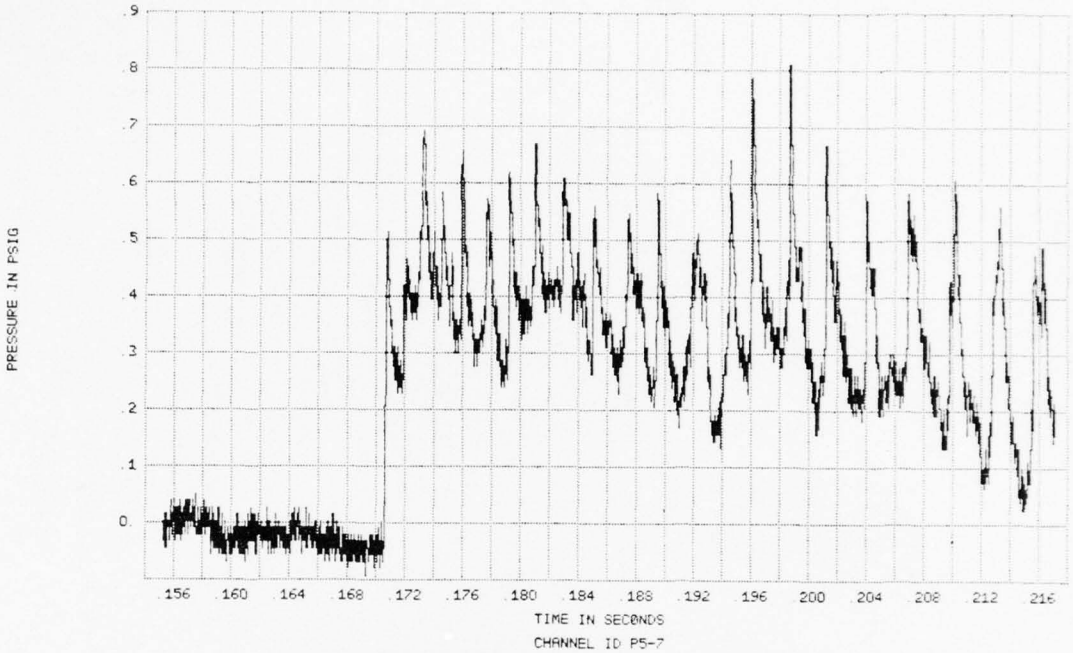


FIGURE 5-22 , SPECIMEN NO. 5 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

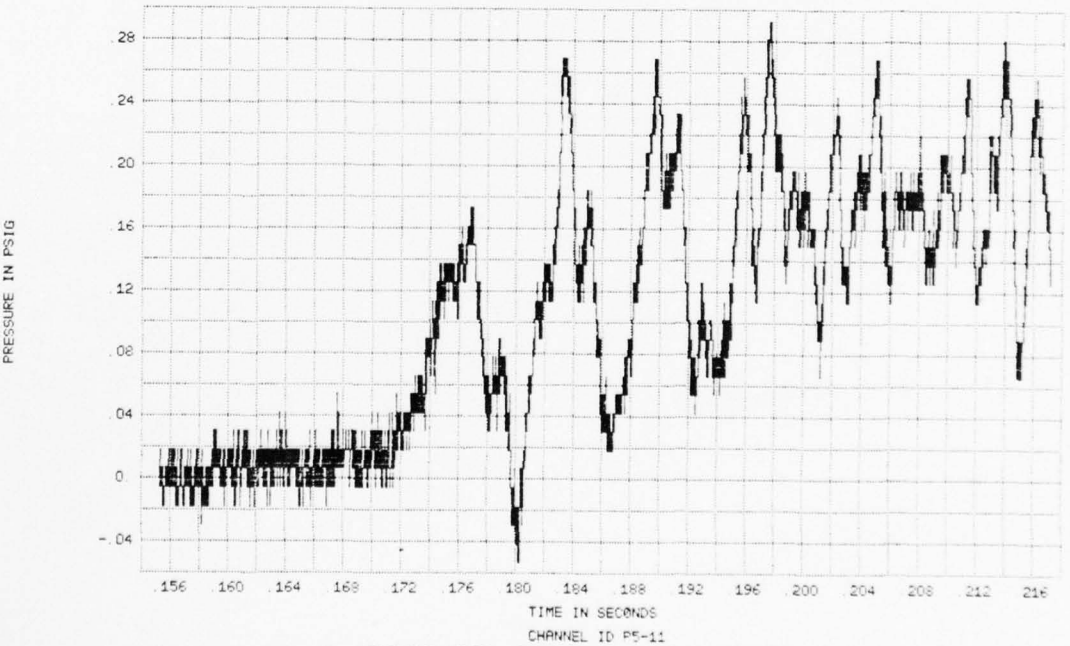


FIGURE 5-23 , SPECIMEN NO. 5 , SHOT NO. 2 ,
INTERNAL PRESSURE TIME HISTORY

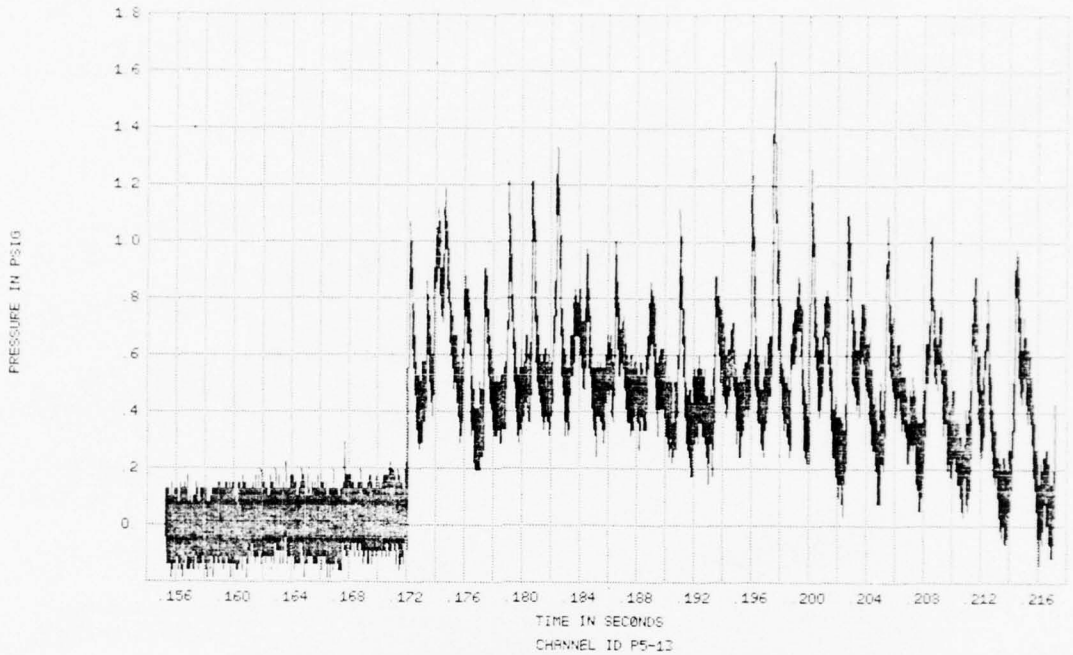


FIGURE 5-24 , SPECIMEN NO. 5 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

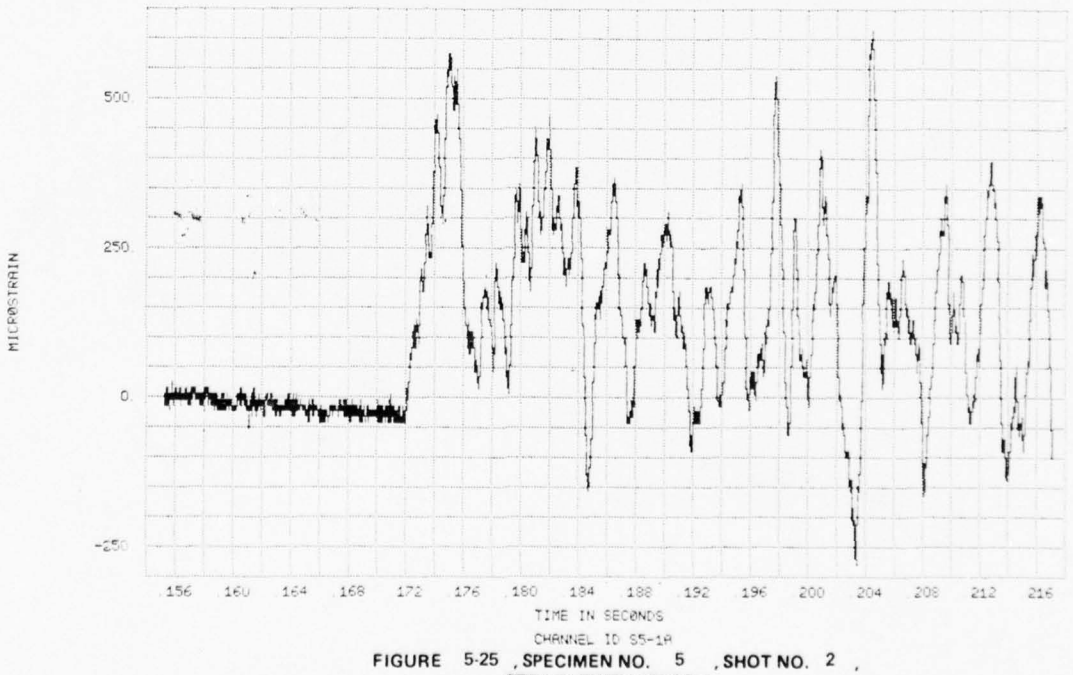


FIGURE 5-25 , SPECIMEN NO. 5 , SHOT NO. 2 ,
STRAIN TIME HISTORY

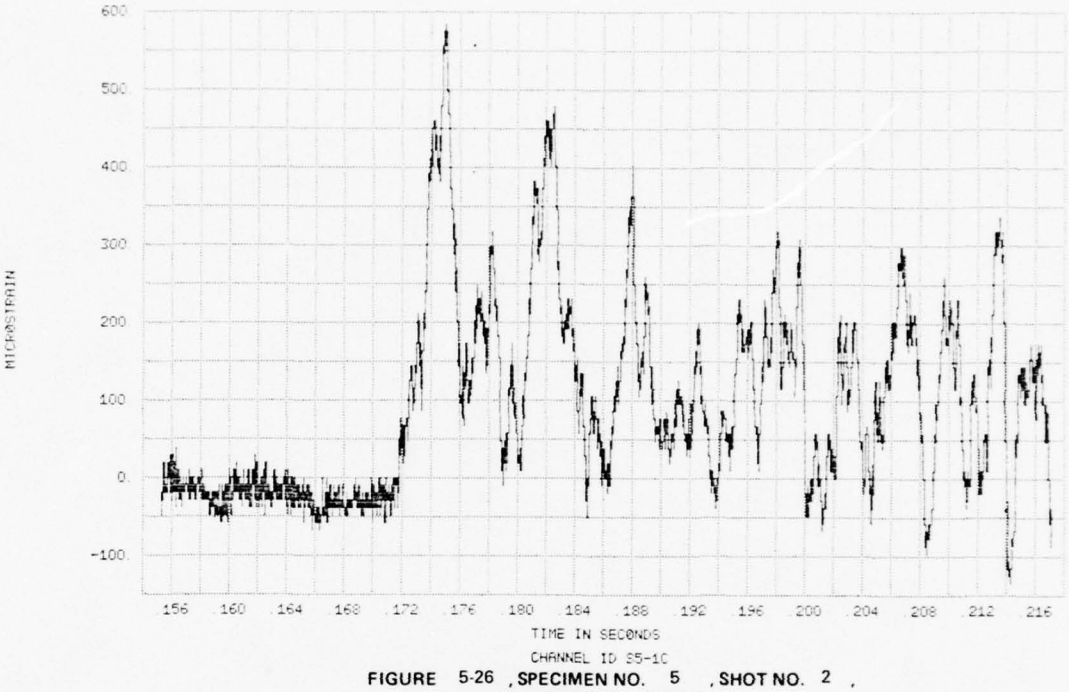


FIGURE 5-26 , SPECIMEN NO. 5 , SHOT NO. 2 ,
STRAIN TIME HISTORY

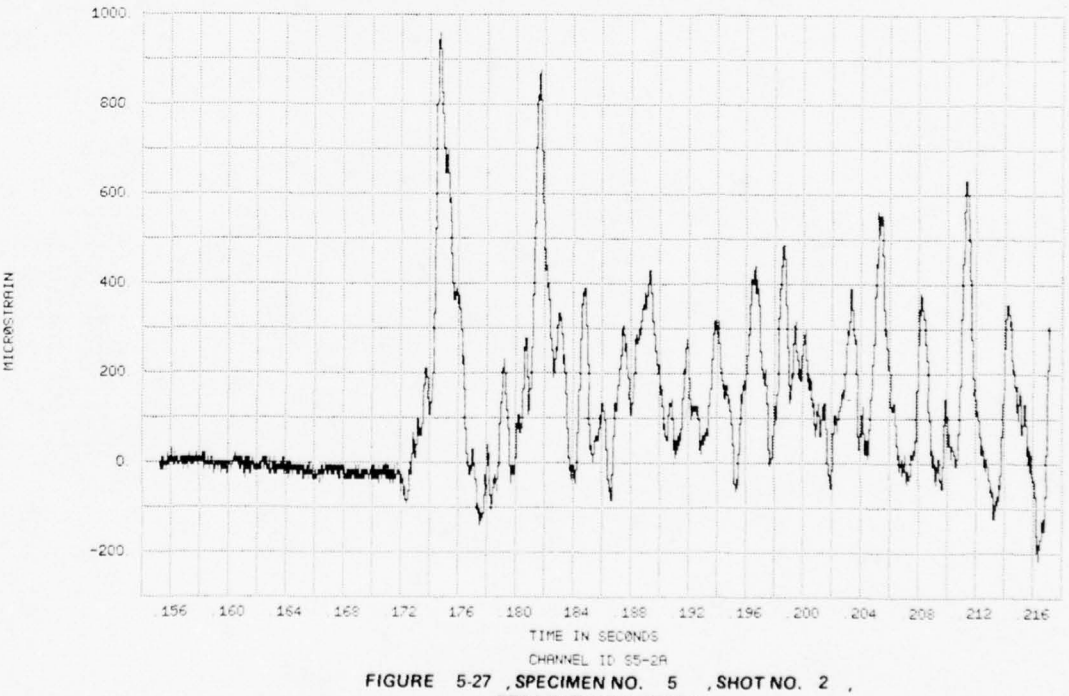


FIGURE 5-27 , SPECIMEN NO. 5 , SHOT NO. 2 ,
STRAIN TIME HISTORY

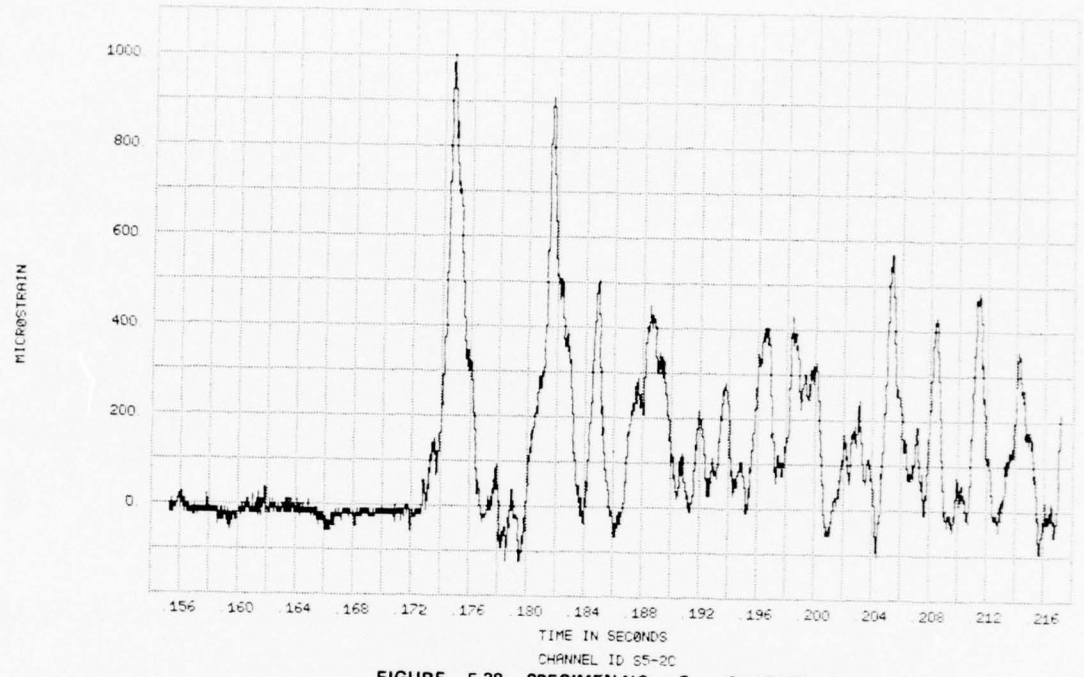


FIGURE 5-28 , SPECIMEN NO. 5 , SHOT NO. 2 ,
STRAIN TIME HISTORY

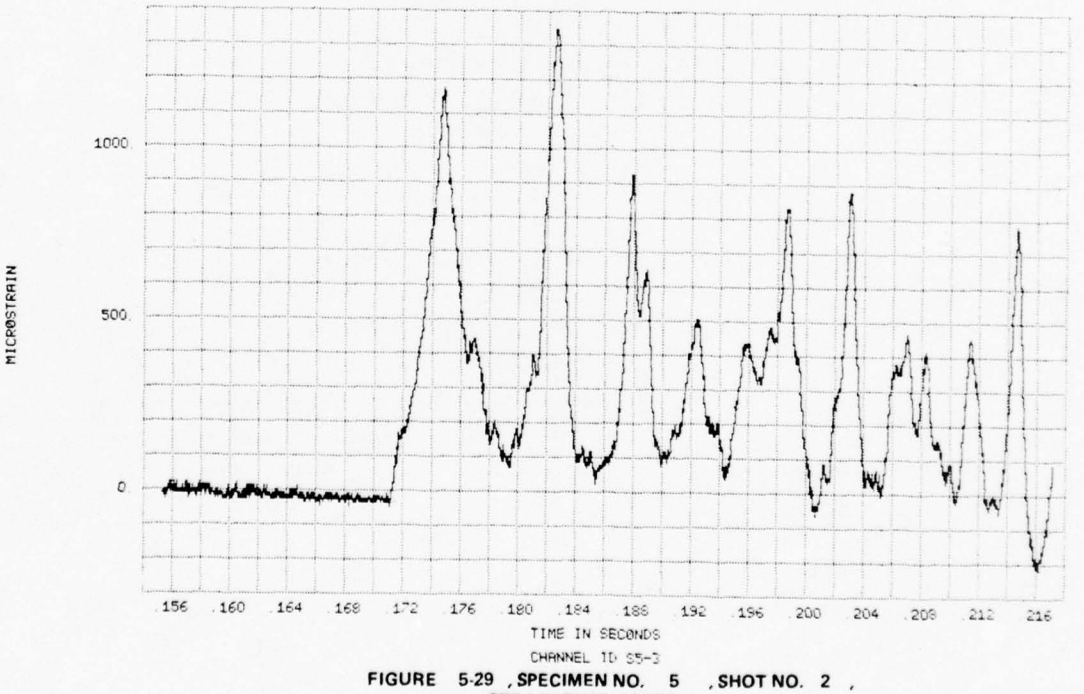


FIGURE 5-29 , SPECIMEN NO. 5 , SHOT NO. 2 ,
STRAIN TIME HISTORY

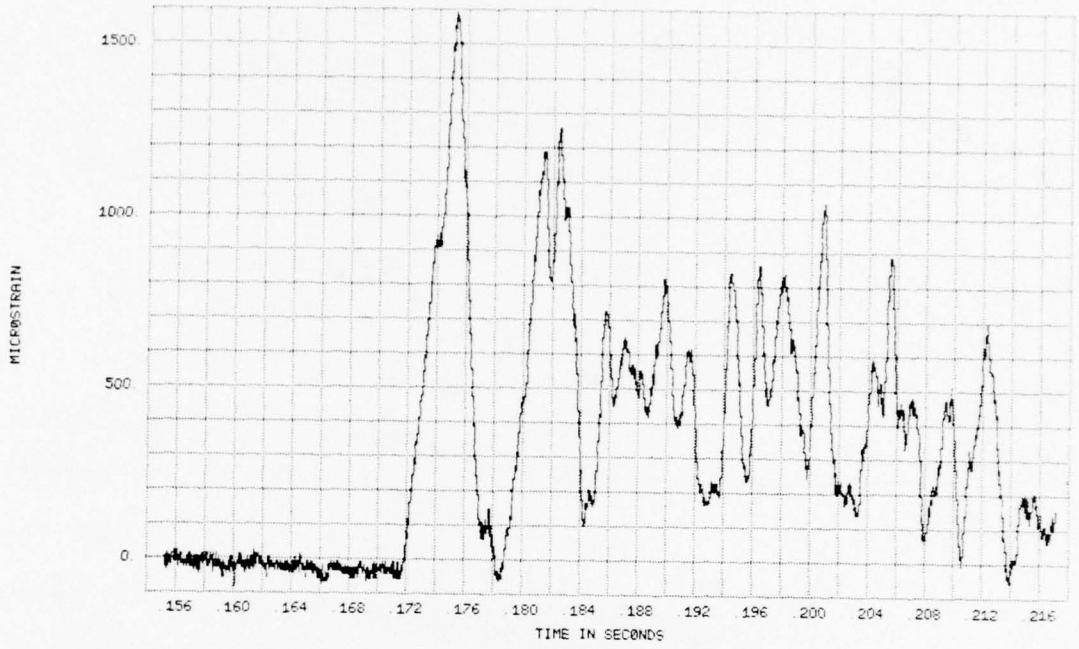


FIGURE 5-30 , SPECIMEN NO. 5 , SHOT NO. 2 , STRAIN TIME HISTORY

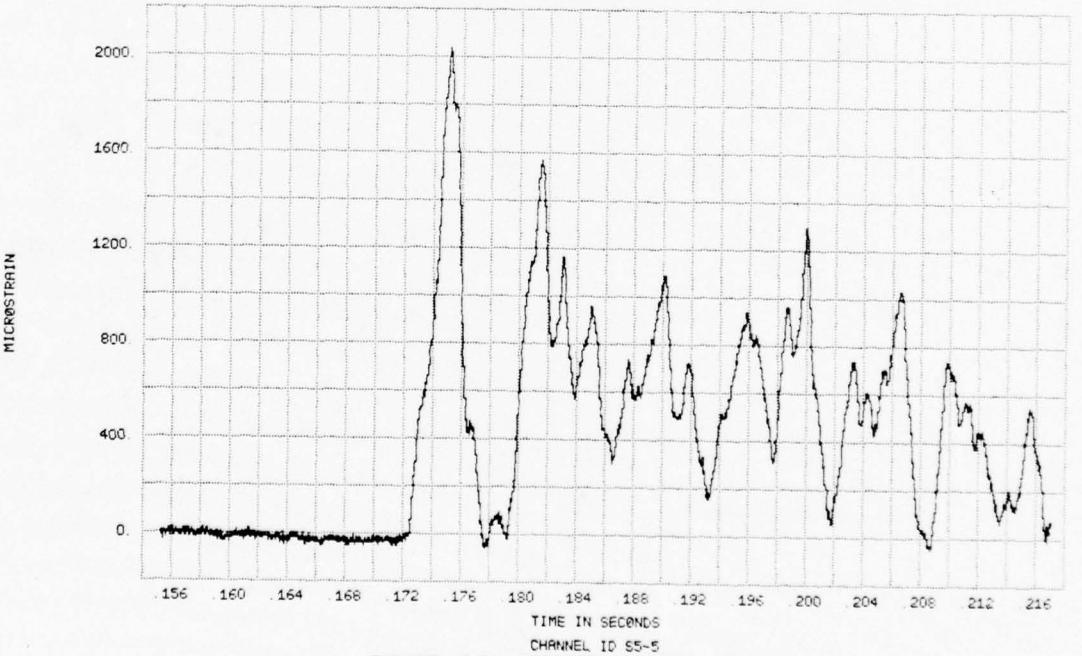


FIGURE 5-31 , SPECIMEN NO. 5 , SHOT NO. 2 , STRAIN TIME HISTORY

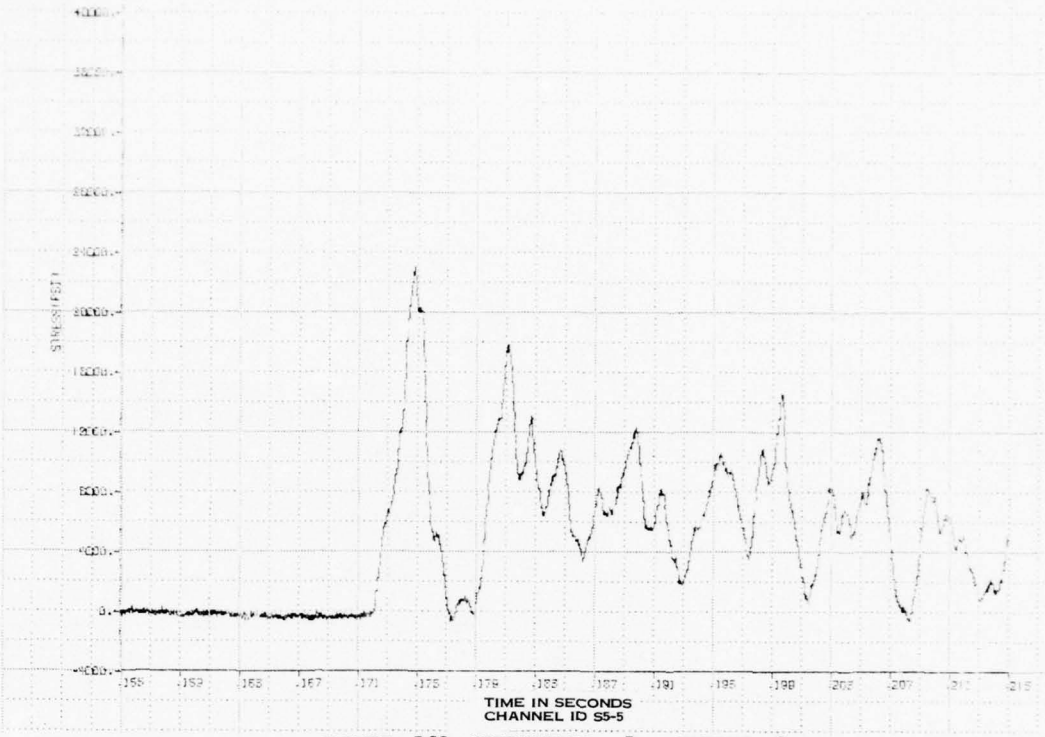


FIGURE 5-32 , SPECIMEN NO. 5 , SHOT NO. 2
STRESS TIME HISTORY

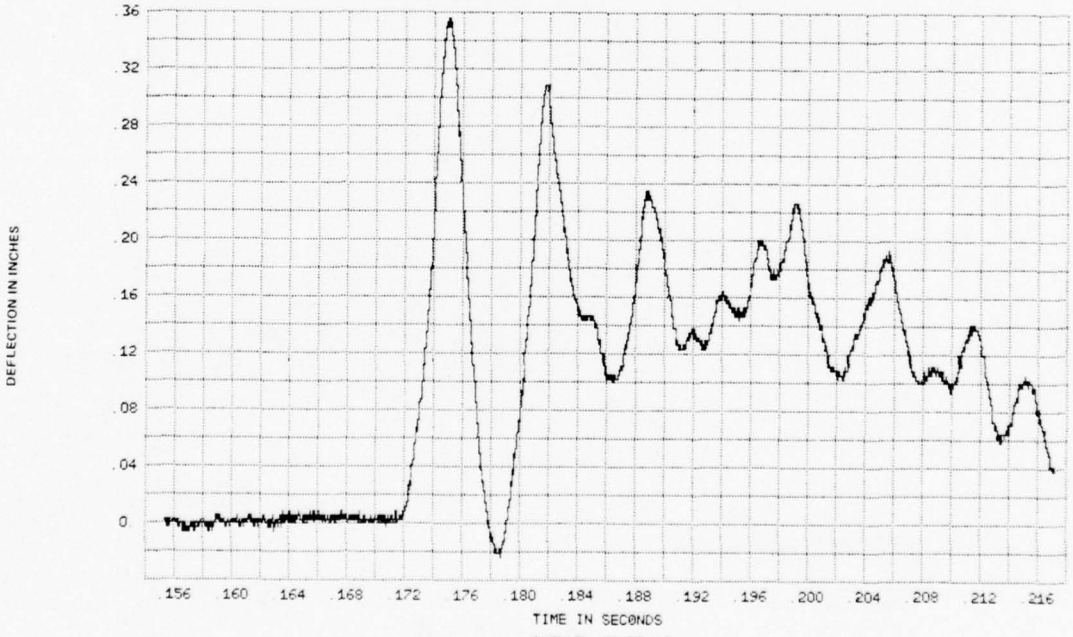


FIGURE 5-33 , SPECIMEN NO. 5 , SHOT NO. 2 ,
DEFLECTION TIME HISTORY

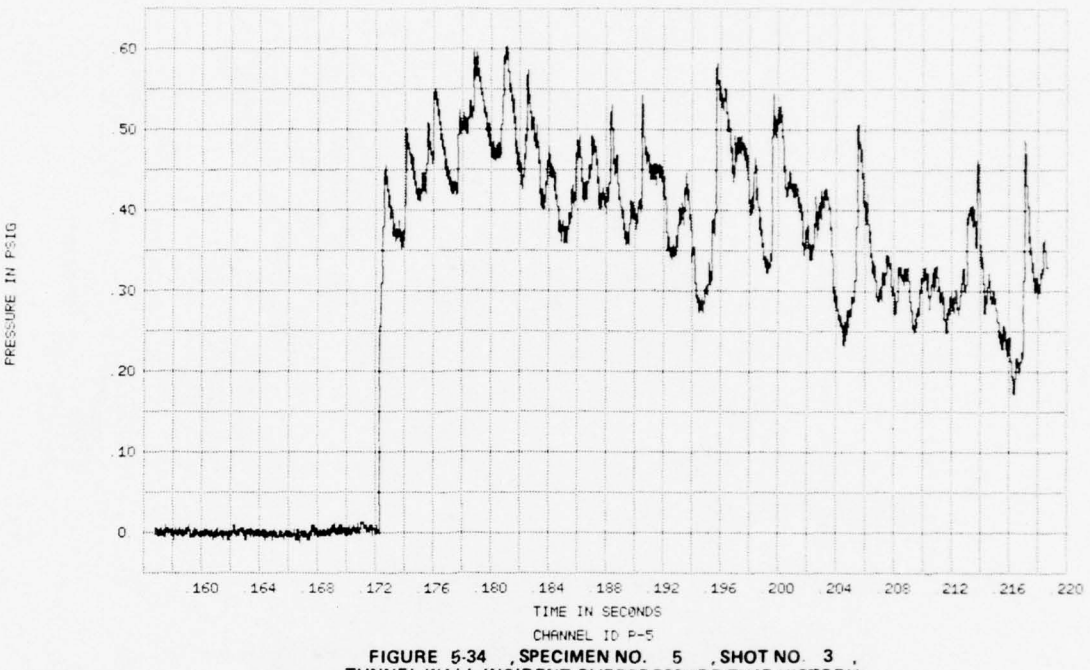


FIGURE 5-34 , SPECIMEN NO. 5 , SHOT NO. 3 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

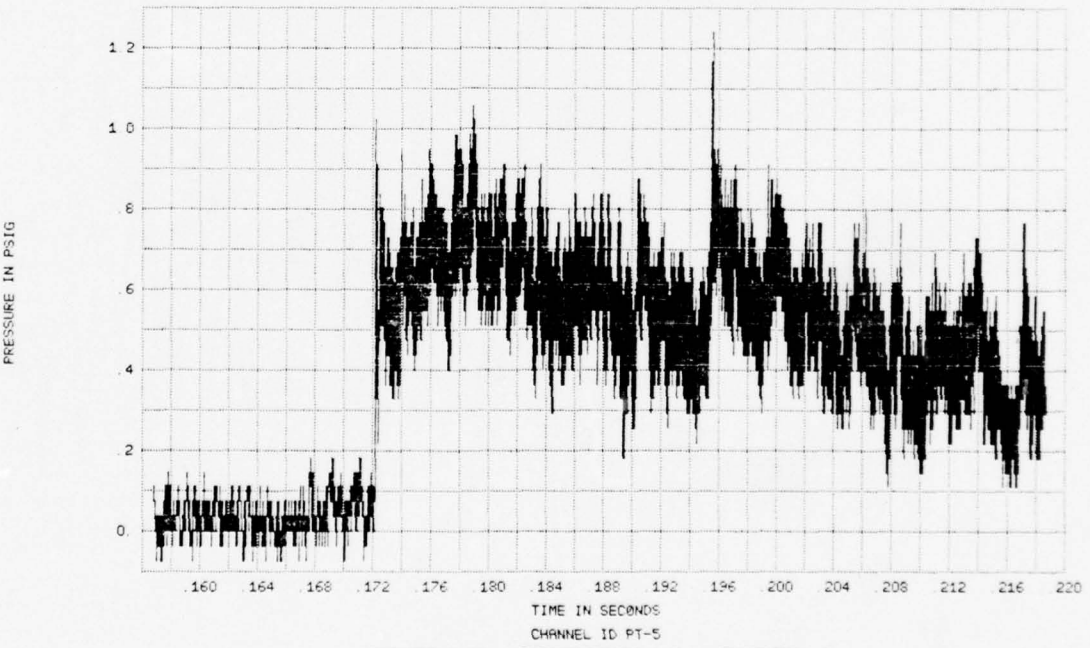


FIGURE 5-35 , SPECIMEN NO. 5 , SHOT NO. 3 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

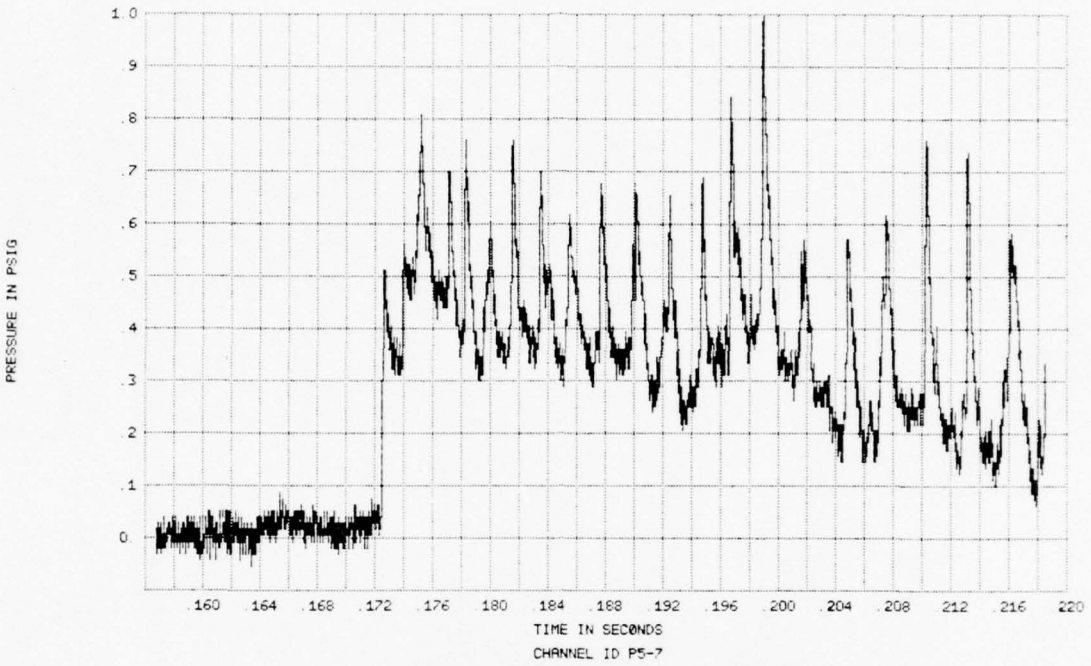


FIGURE 5-36 , SPECIMEN NO. 5 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

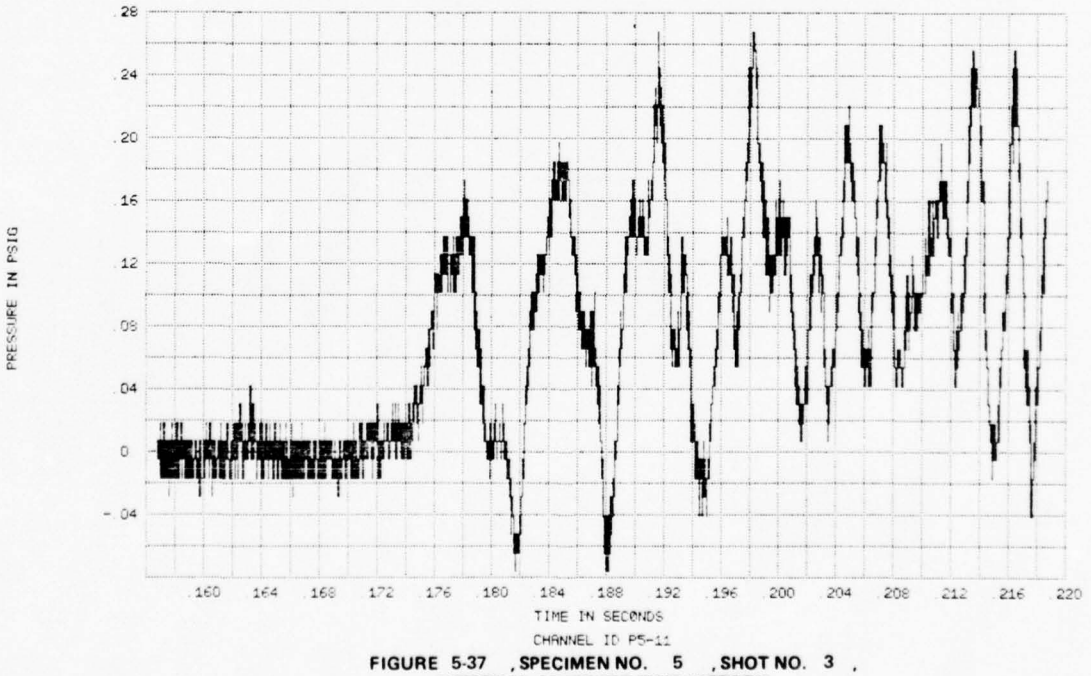


FIGURE 5-37 , SPECIMEN NO. 5 , SHOT NO. 3 ,
INTERNAL PRESSURE TIME HISTORY

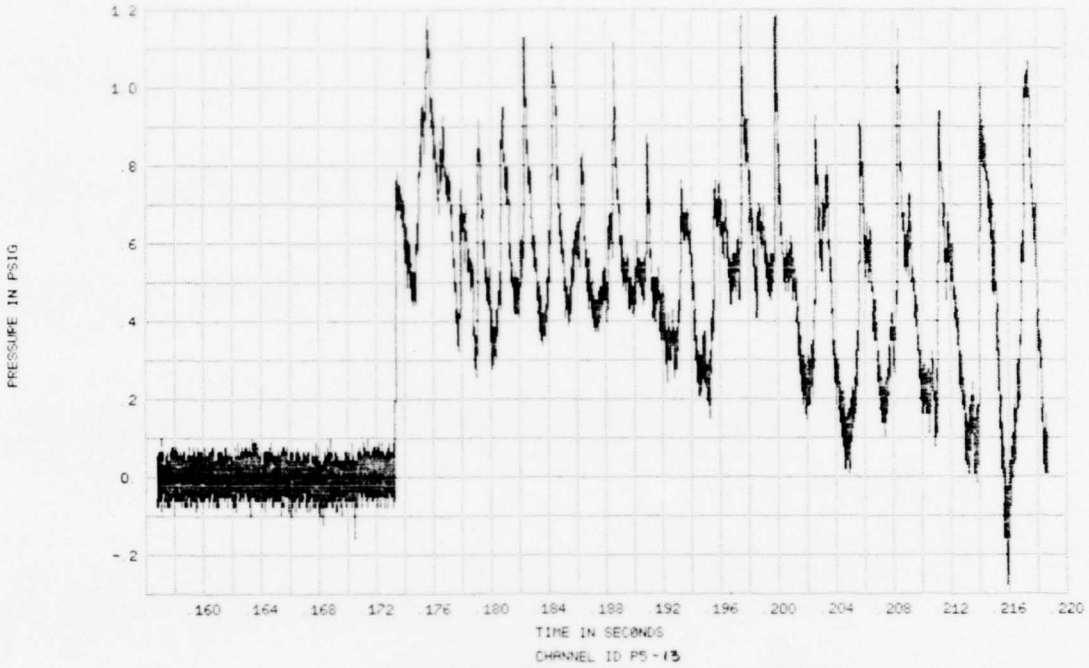


FIGURE 5-38 , SPECIMEN NO. 5 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

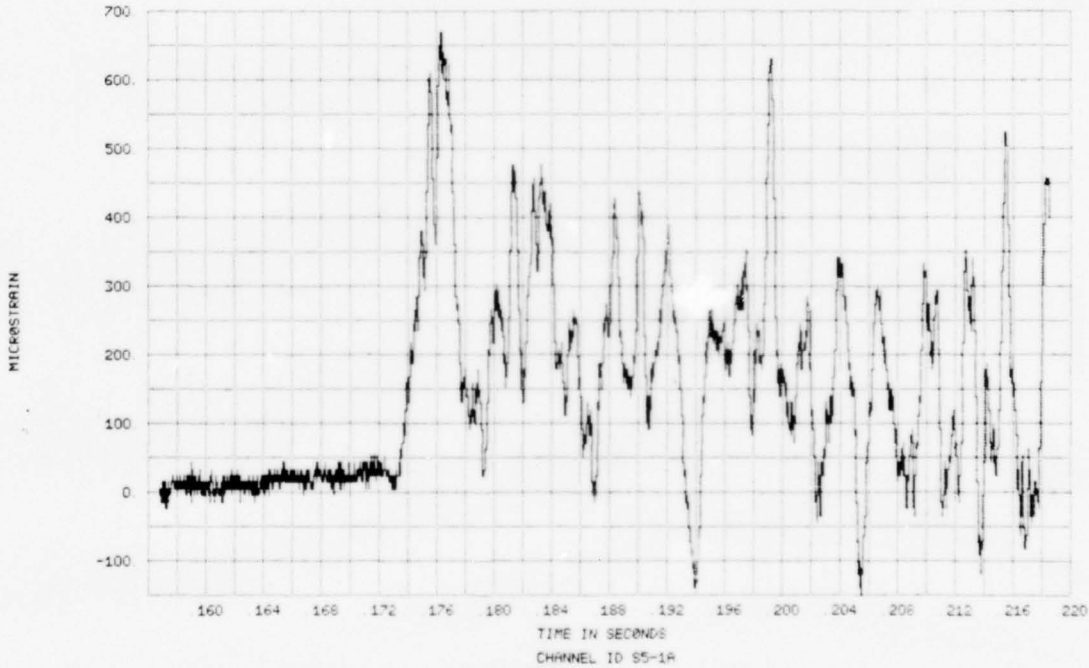


FIGURE 5-39 , SPECIMEN NO. 5 , SHOT NO. 3 ,
STRAIN TIME HISTORY

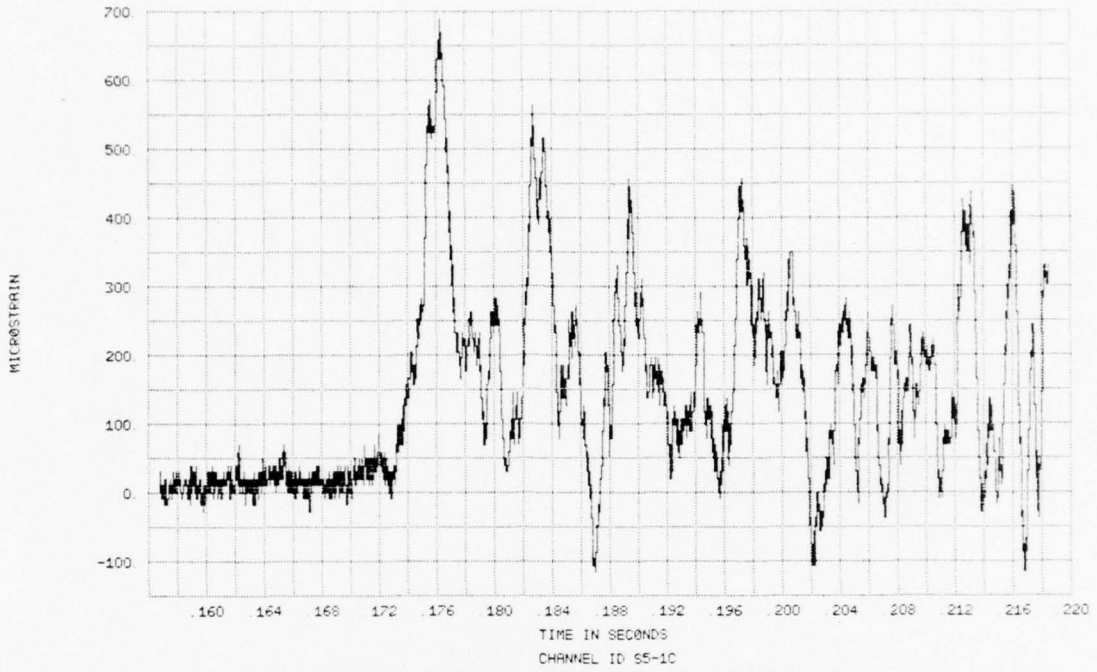


FIGURE 5-40 , SPECIMEN NO. 5 , SHOT NO. 3 , STRAIN TIME HISTORY

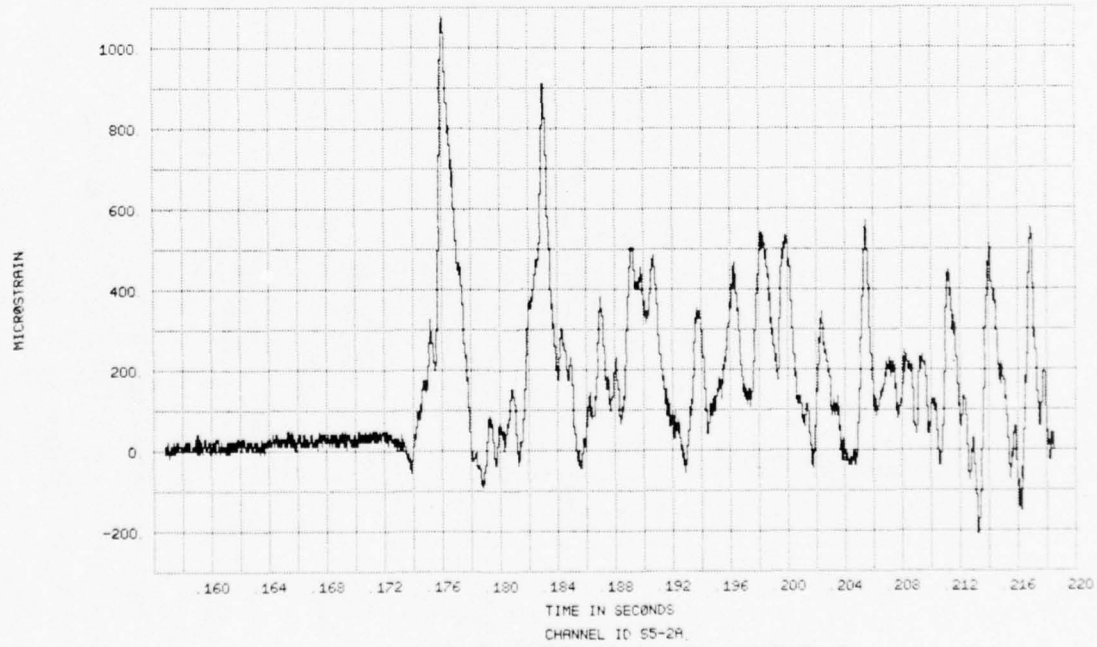


FIGURE 5-41 , SPECIMEN NO. 5 , SHOT NO. 3 , STRAIN TIME HISTORY

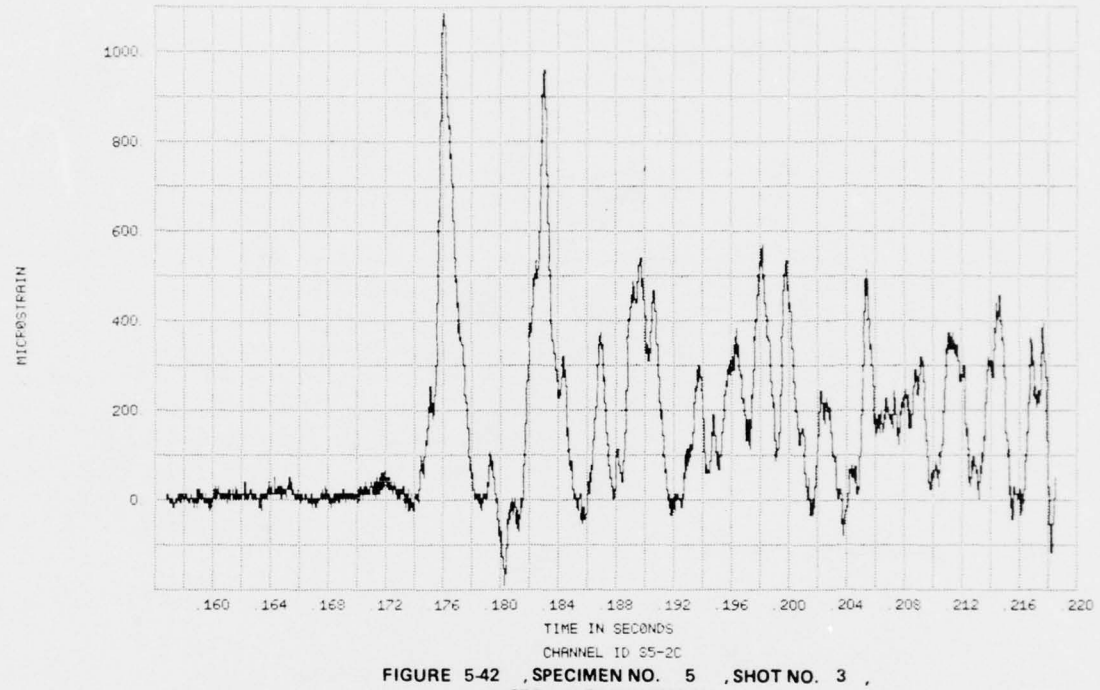


FIGURE 5-42 , SPECIMEN NO. 5 , SHOT NO. 3 ,
STRAIN TIME HISTORY

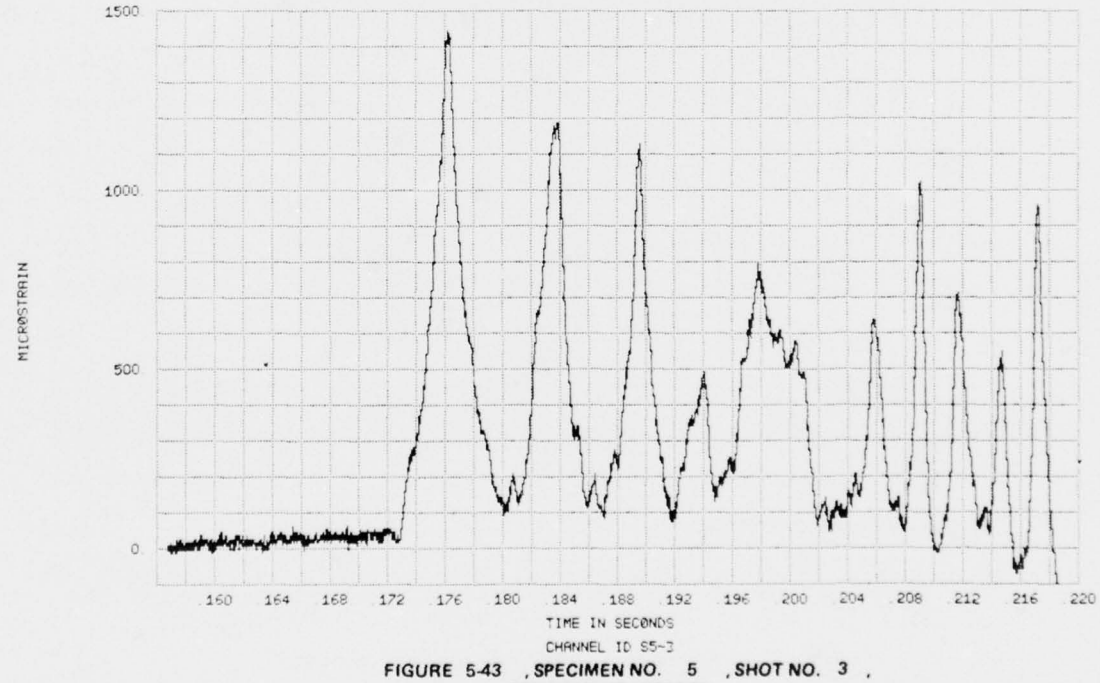


FIGURE 5-43 , SPECIMEN NO. 5 , SHOT NO. 3 ,
STRAIN TIME HISTORY

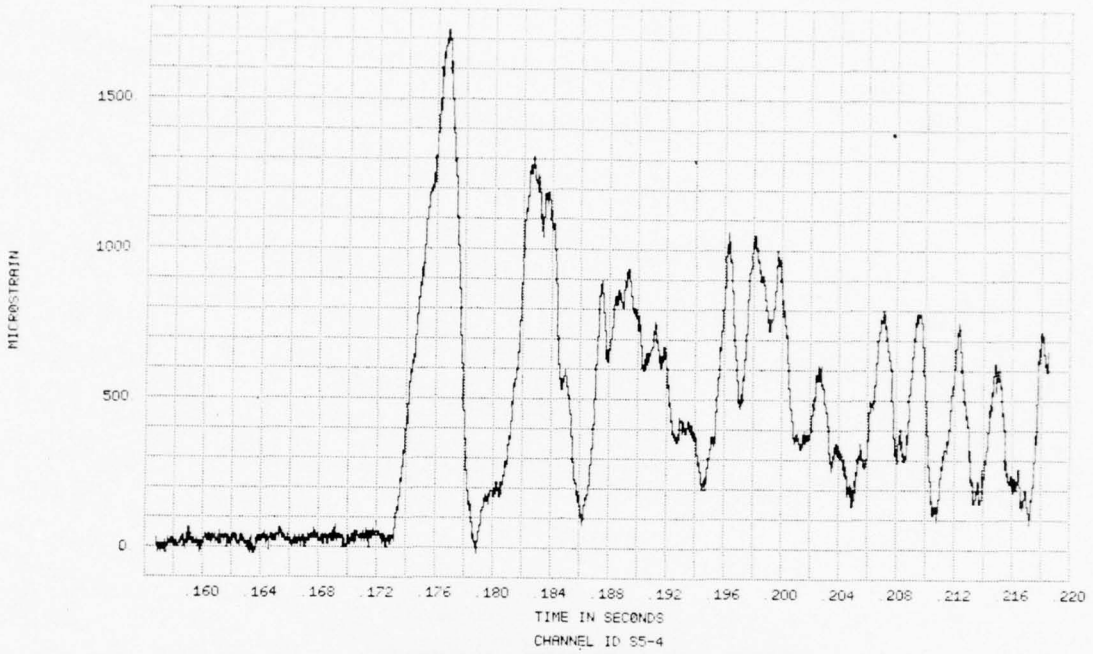


FIGURE 5-44 , SPECIMEN NO. 5 , SHOT NO. 3 , STRAIN TIME HISTORY

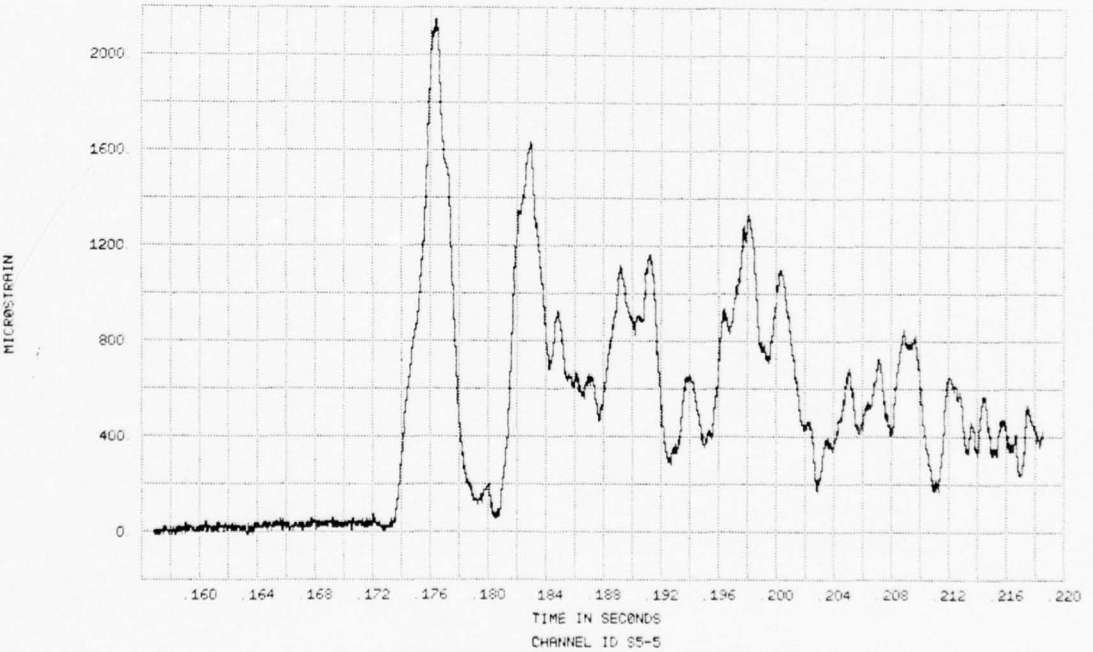


FIGURE 5-45 , SPECIMEN NO. 5 , SHOT NO. 3 , STRAIN TIME HISTORY

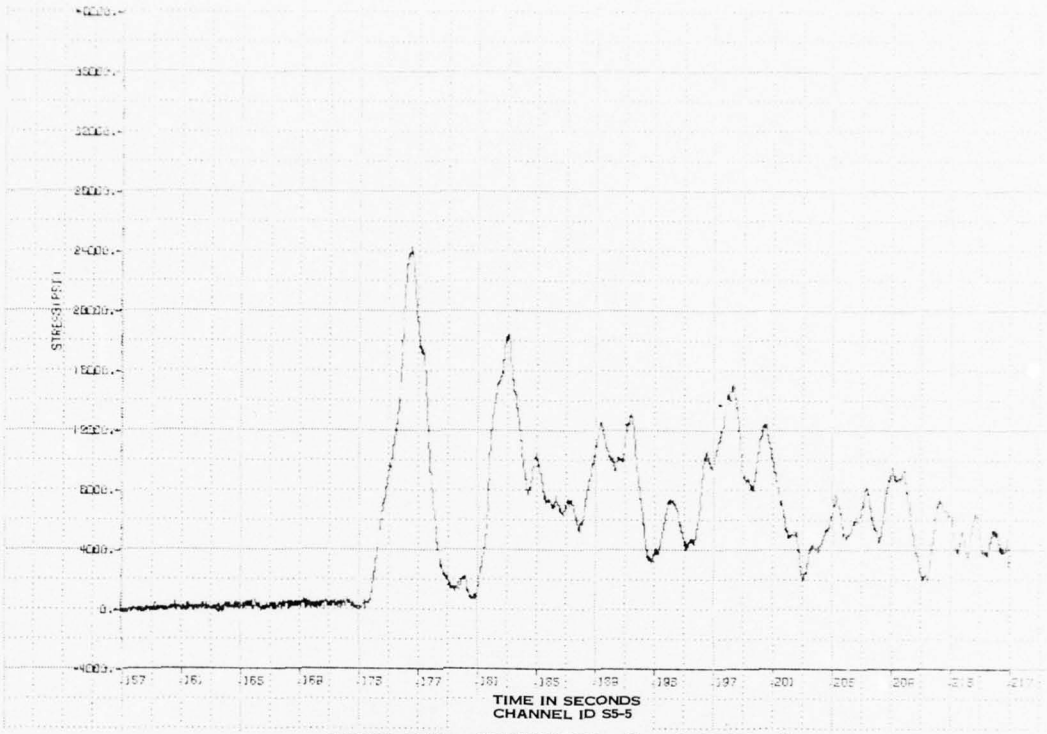


FIGURE 5-46 , SPECIMEN NO. 5 , SHOT NO. 3 ,
STRESS TIME HISTORY

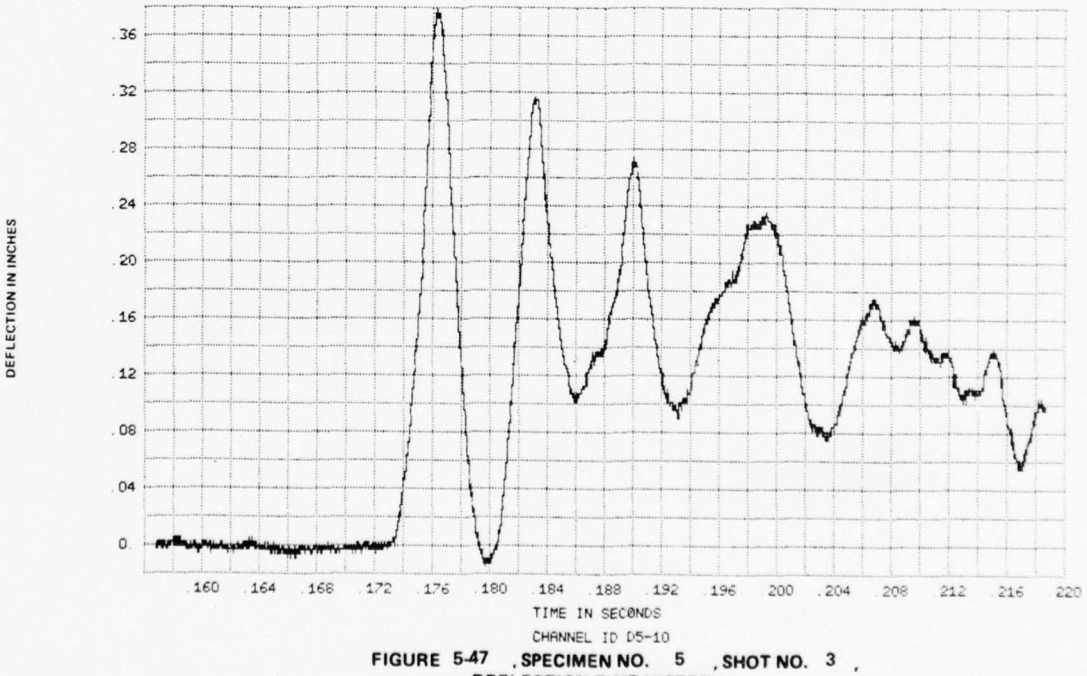


FIGURE 5-47 , SPECIMEN NO. 5 , SHOT NO. 3 ,
DEFLECTION TIME HISTORY

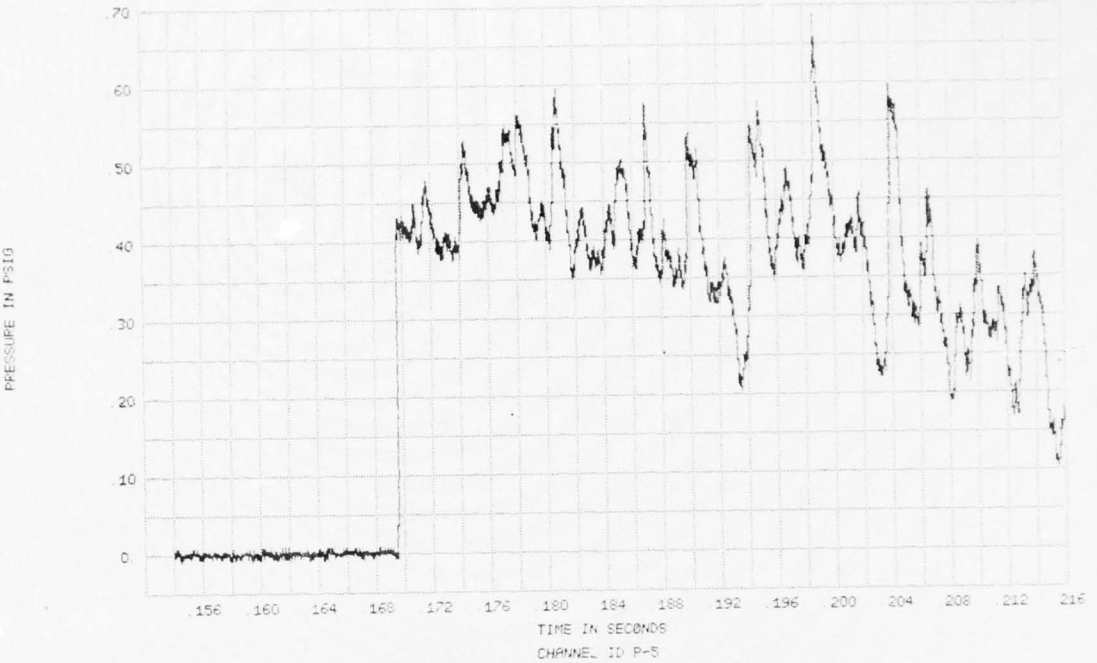


FIGURE 5-48 , SPECIMEN NO. 5 , SHOT NO. 4 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

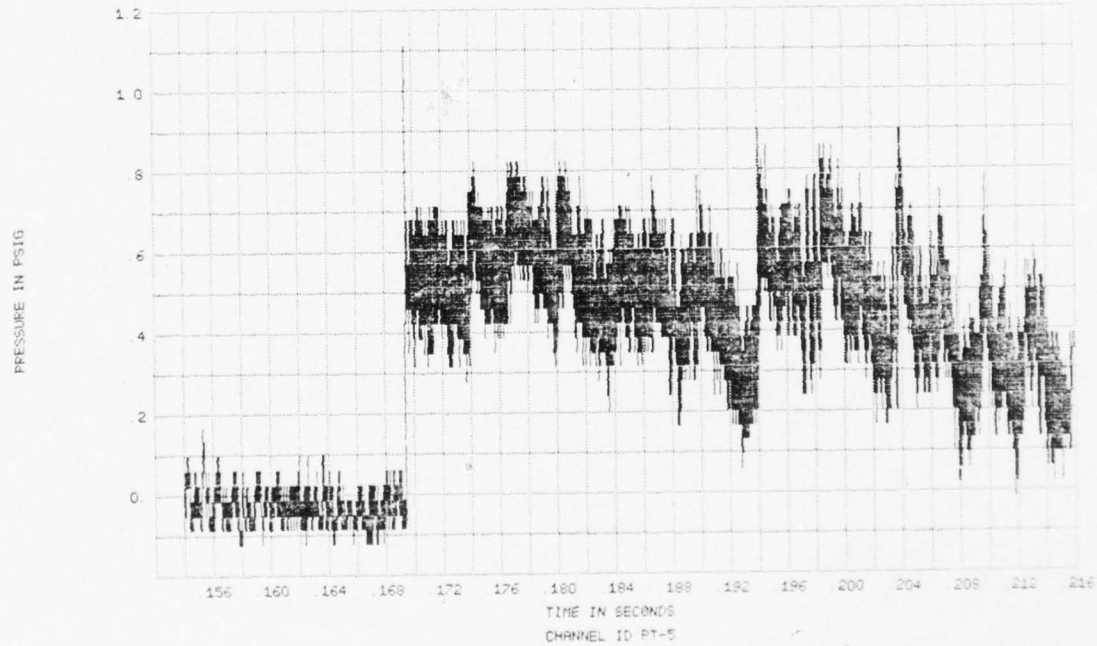


FIGURE 5-49 , SPECIMEN NO. 5 , SHOT NO. 4 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

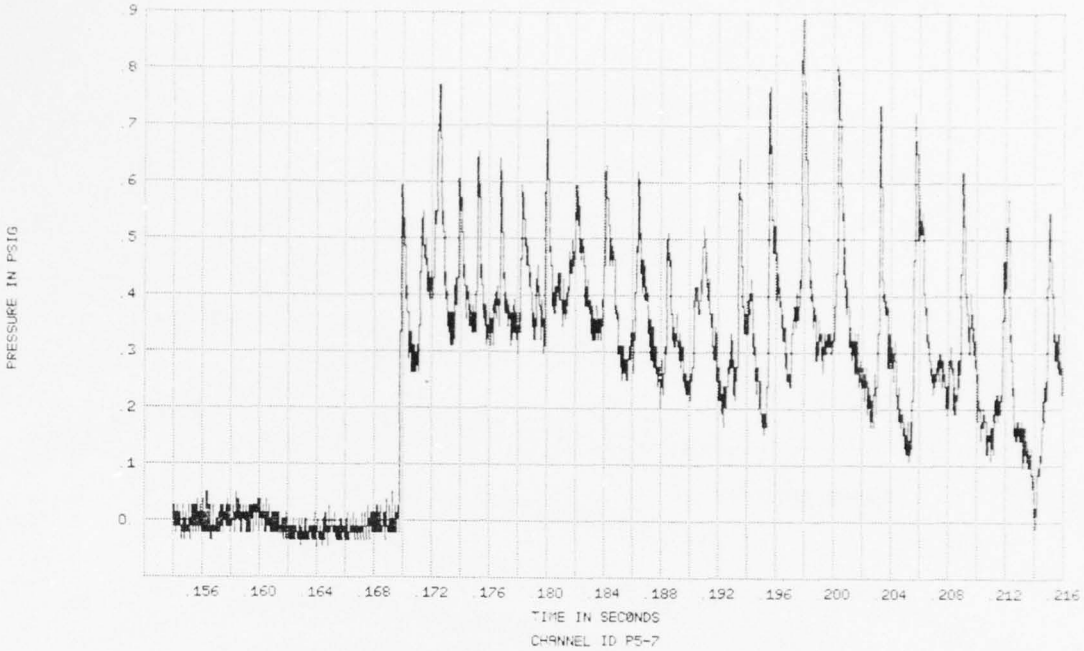


FIGURE 5-50 , SPECIMEN NO. 5 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

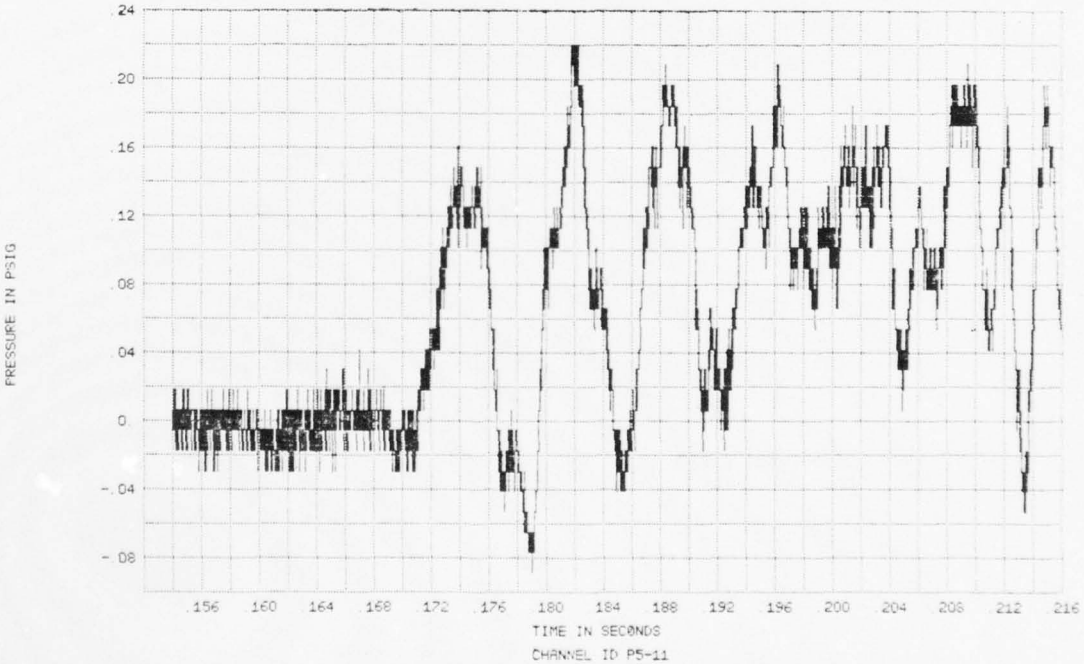


FIGURE 5-51 , SPECIMEN NO. 5 , SHOT NO. 4 ,
INTERNAL PRESSURE TIME HISTORY

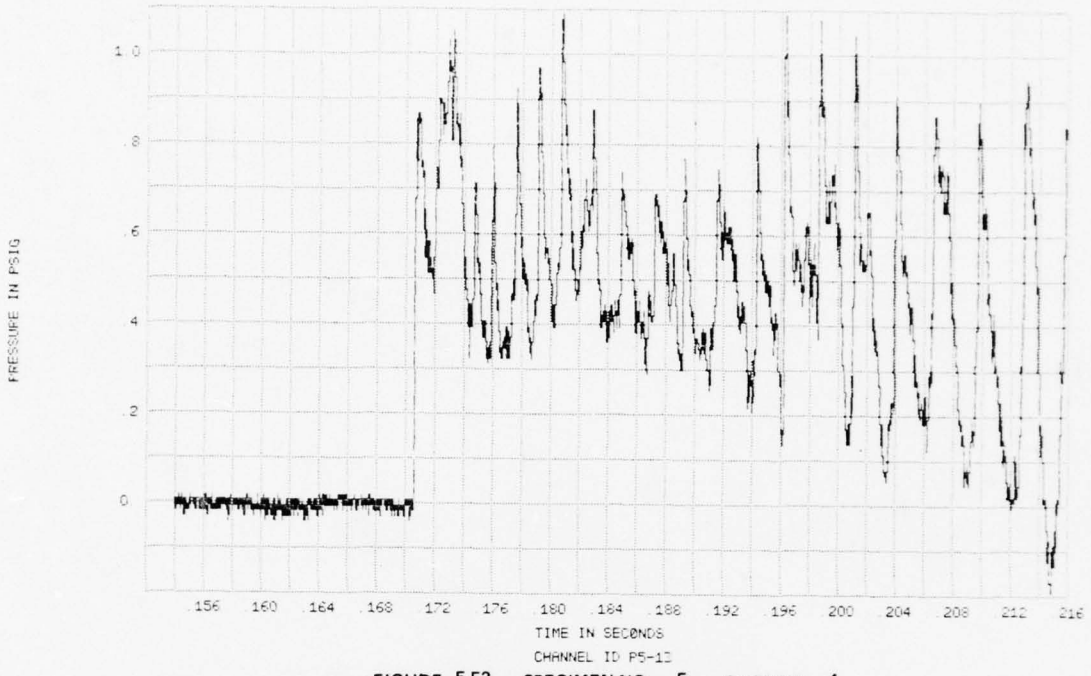


FIGURE 5-52 , SPECIMEN NO. 5 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

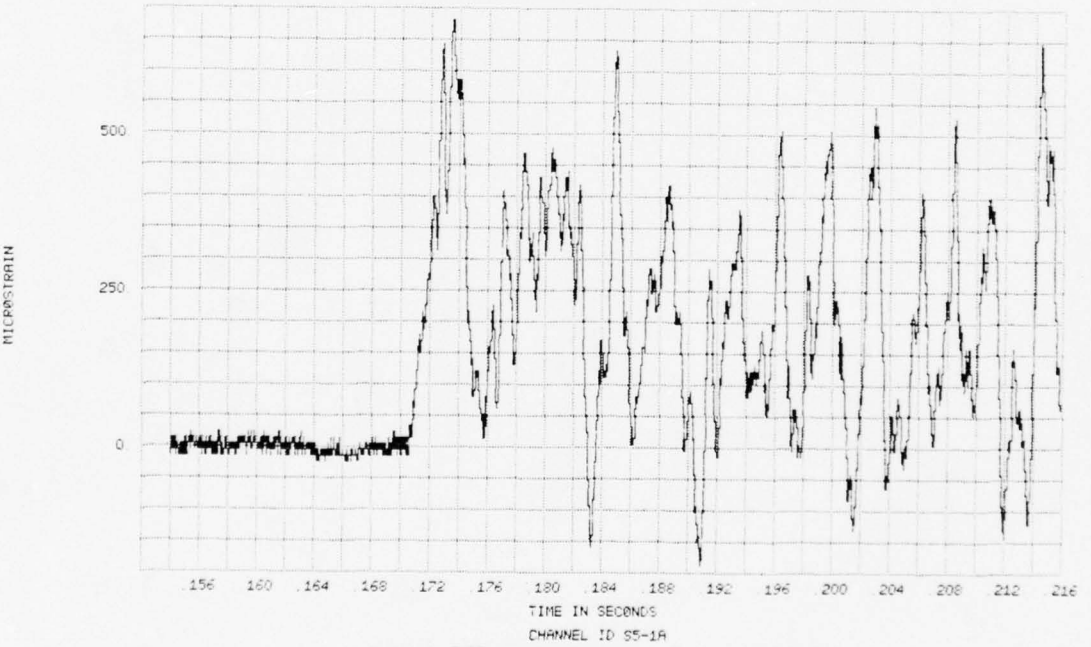


FIGURE 5-53 , SPECIMEN NO. 5 , SHOT NO. 4 ,
STRAIN TIME HISTORY

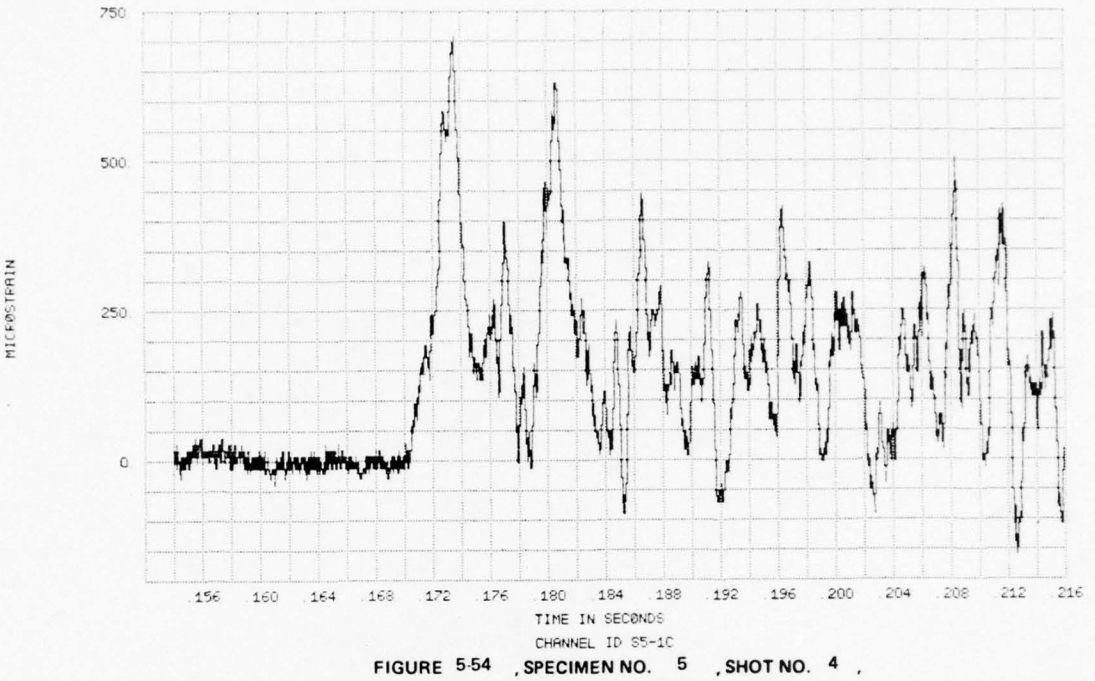


FIGURE 5-54 , SPECIMEN NO. 5 , SHOT NO. 4 ,
STRAIN TIME HISTORY

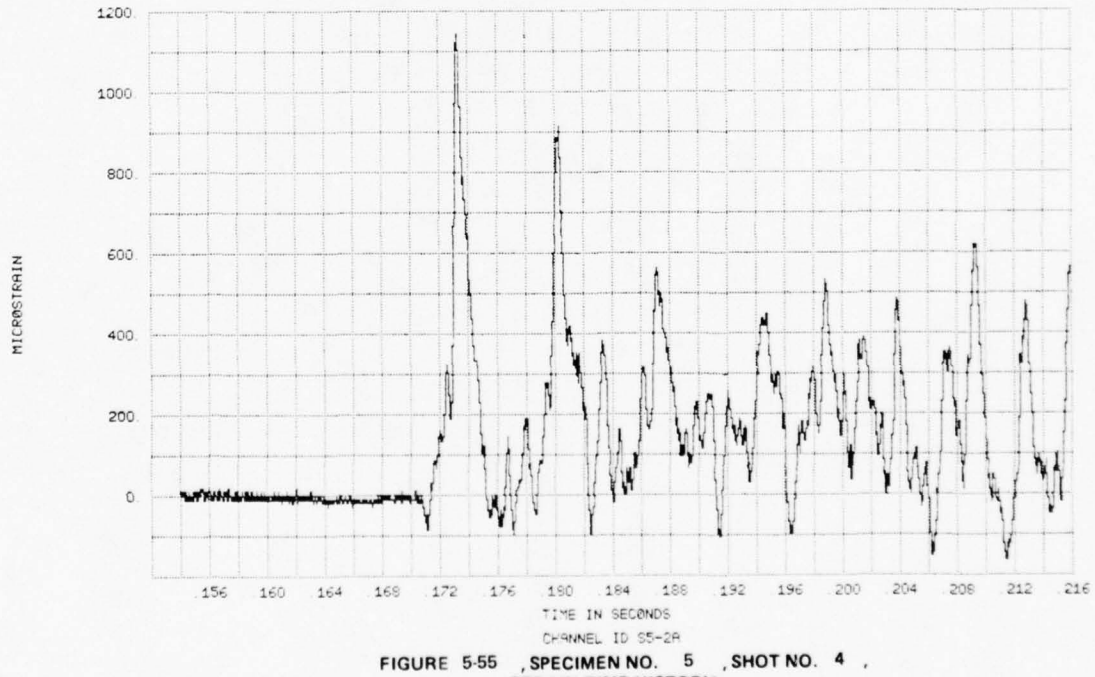


FIGURE 5-55 , SPECIMEN NO. 5 , SHOT NO. 4 ,
STRAIN TIME HISTORY

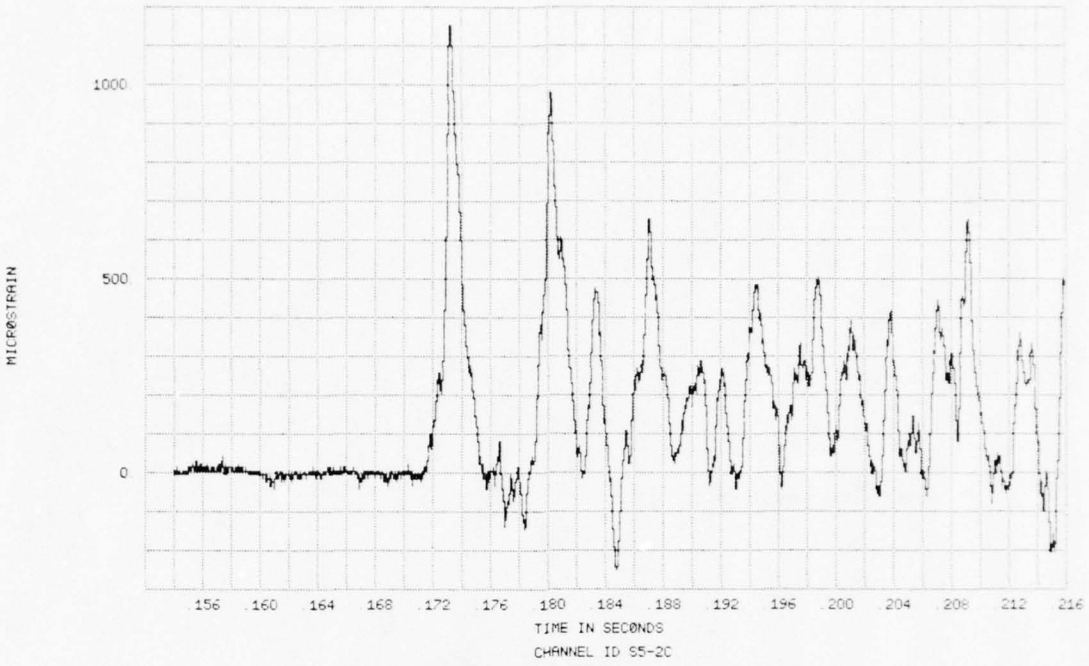


FIGURE 5-56 , SPECIMEN NO. 5 , SHOT NO. 4 ,
STRAIN TIME HISTORY

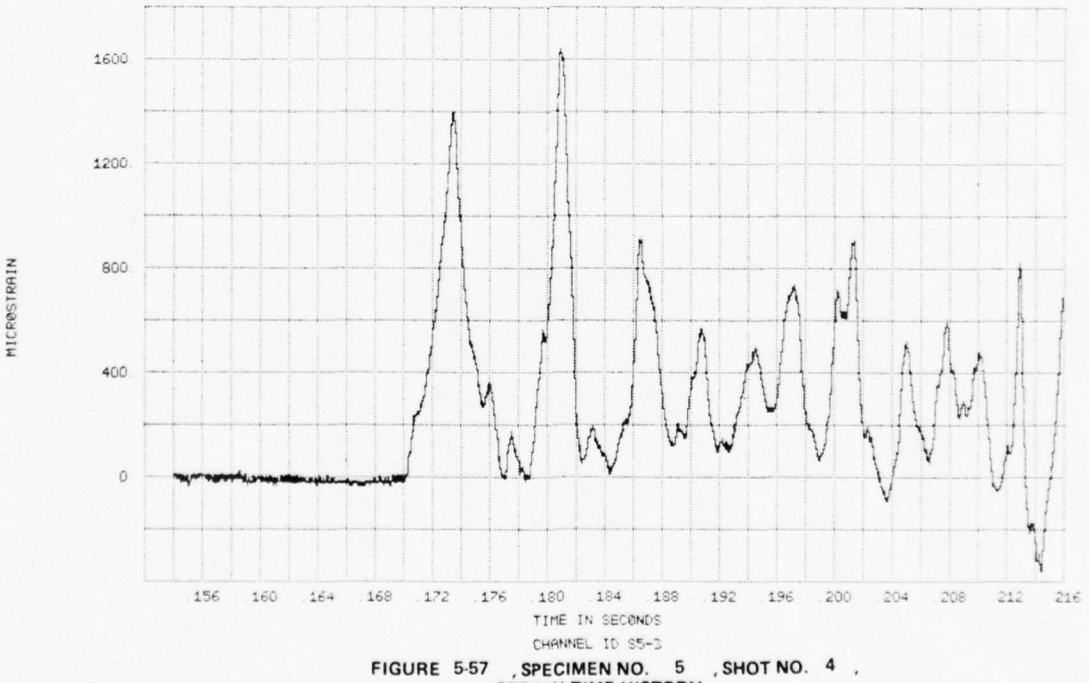


FIGURE 5-57 , SPECIMEN NO. 5 , SHOT NO. 4 ,
STRAIN TIME HISTORY

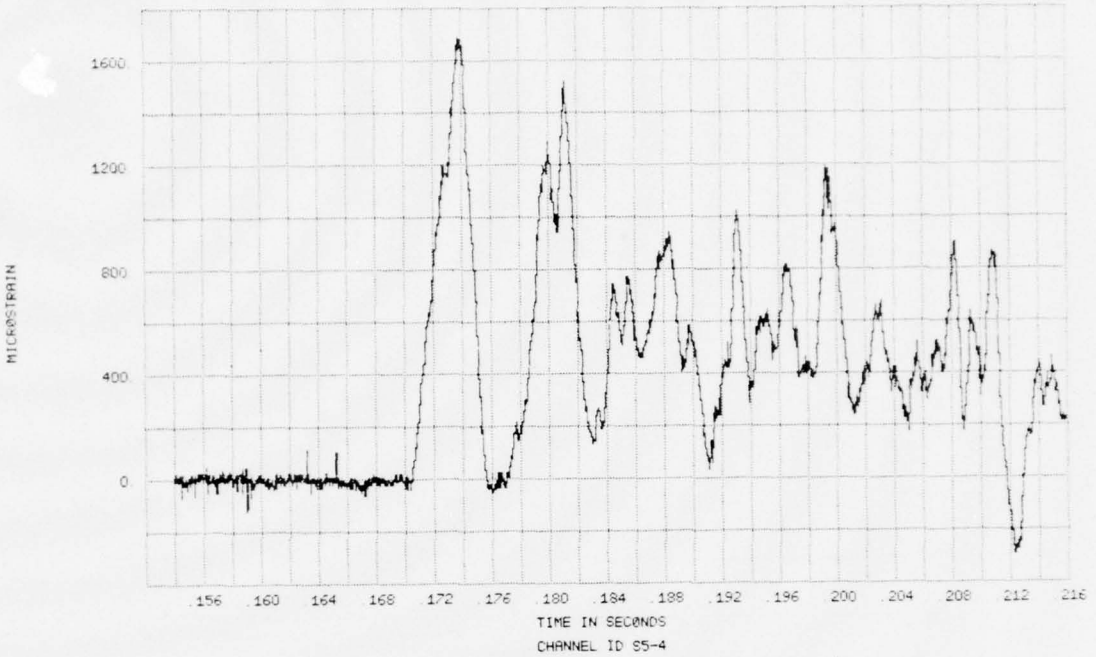


FIGURE 5-58 , SPECIMEN NO. 5 , SHOT NO. 4 ,
STRAIN TIME HISTORY

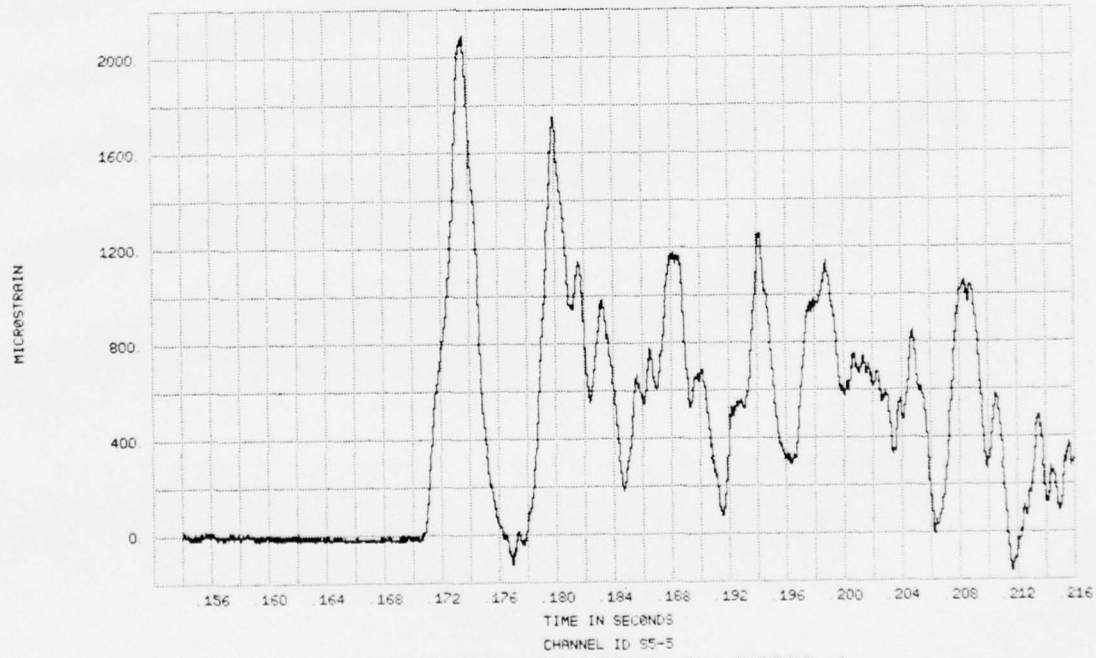


FIGURE 5-59 , SPECIMEN NO. 5 , SHOT NO. 4 ,
STRAIN TIME HISTORY

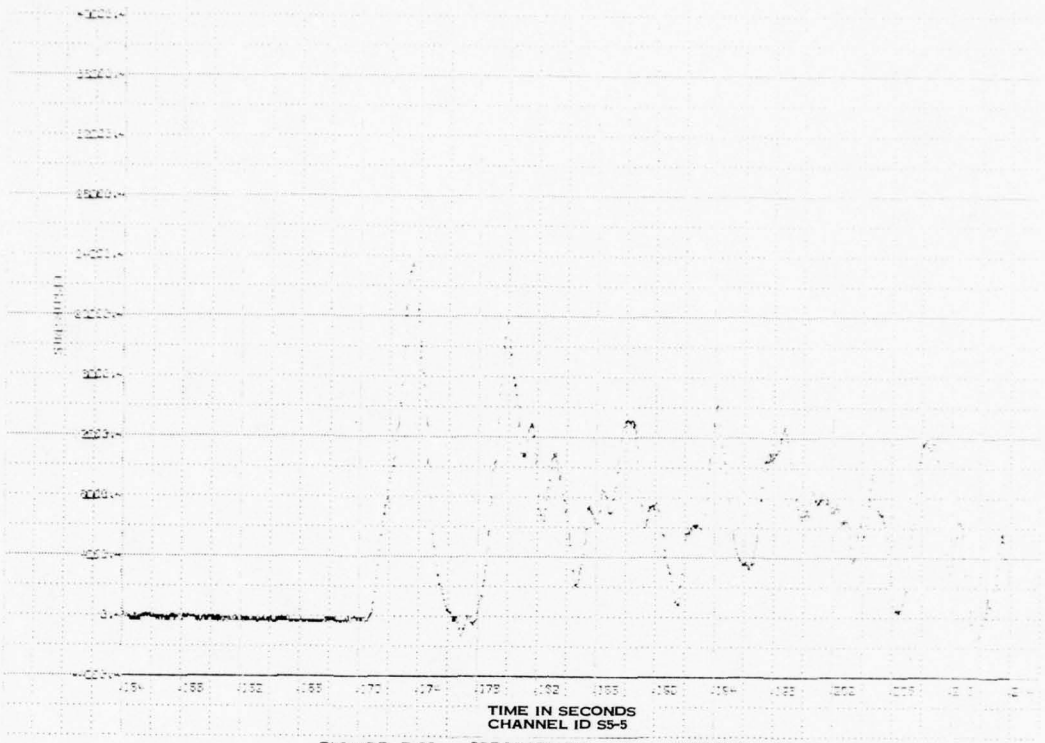


FIGURE 5-60 , SPECIMEN NO. 5 , SHOT NO. 4 ,
STRESS TIME HISTORY

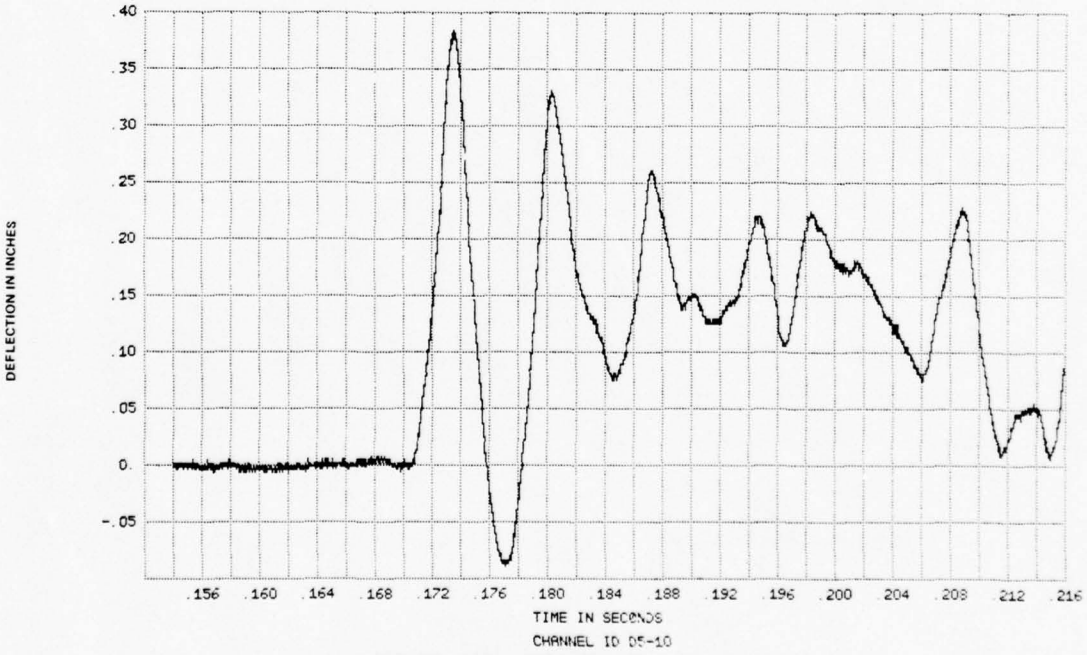


FIGURE 5-61 , SPECIMEN NO. 5 , SHOT NO. 4 ,
DEFLECTION TIME HISTORY

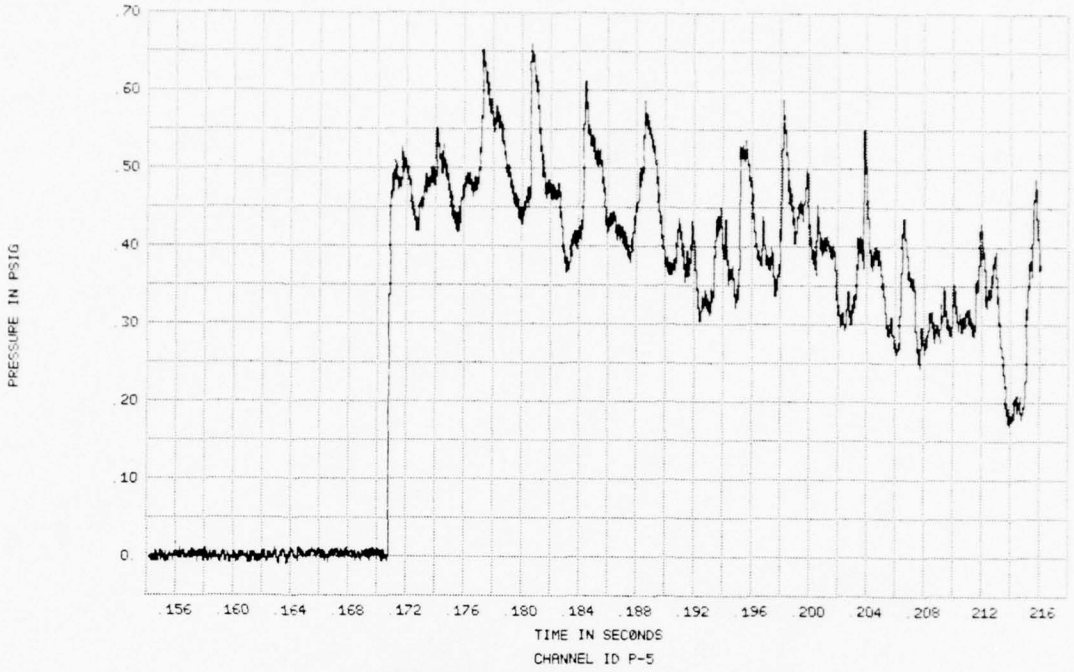


FIGURE 5-62 , SPECIMEN NO. 5 , SHOT NO. 5 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

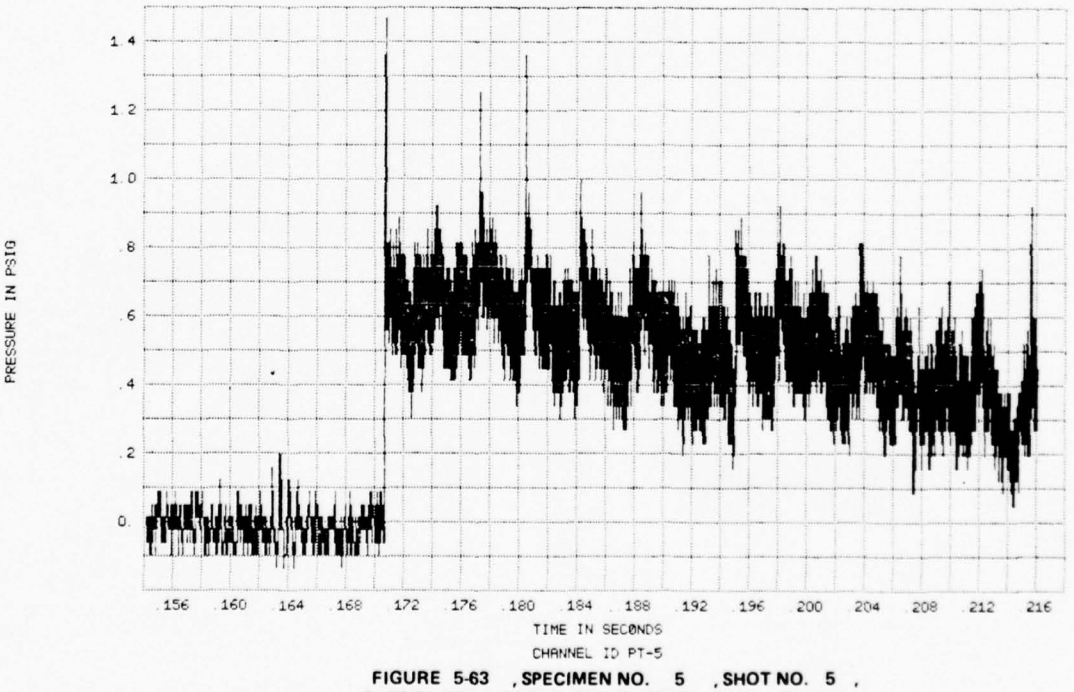


FIGURE 5-63 , SPECIMEN NO. 5 , SHOT NO. 5 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

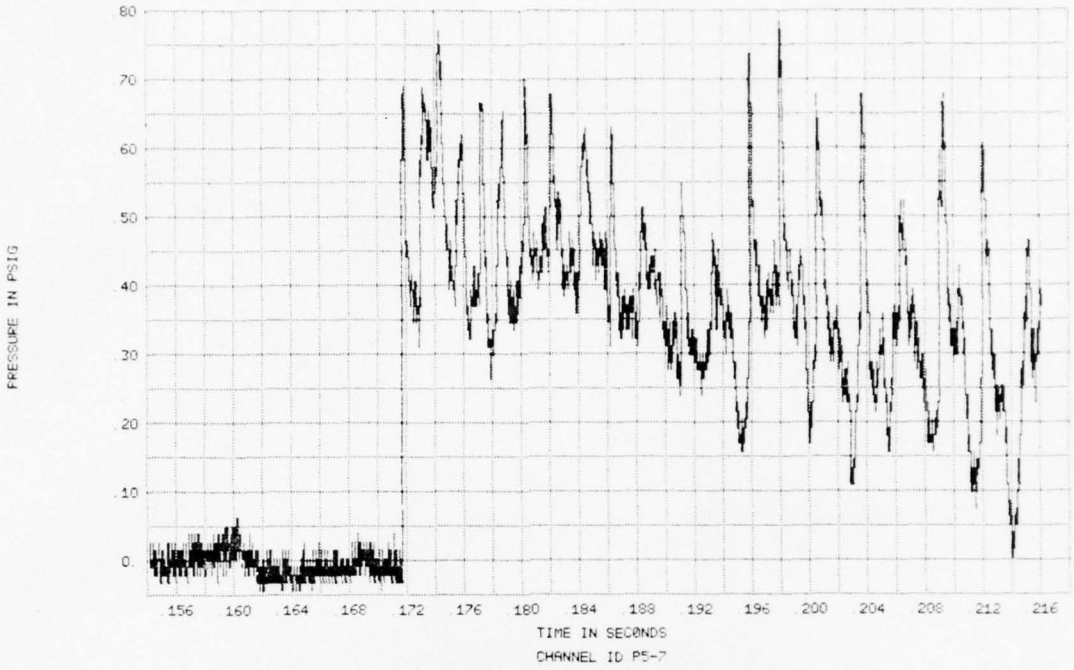


FIGURE 5-64 , SPECIMEN NO. 5 , SHOT NO. 5 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

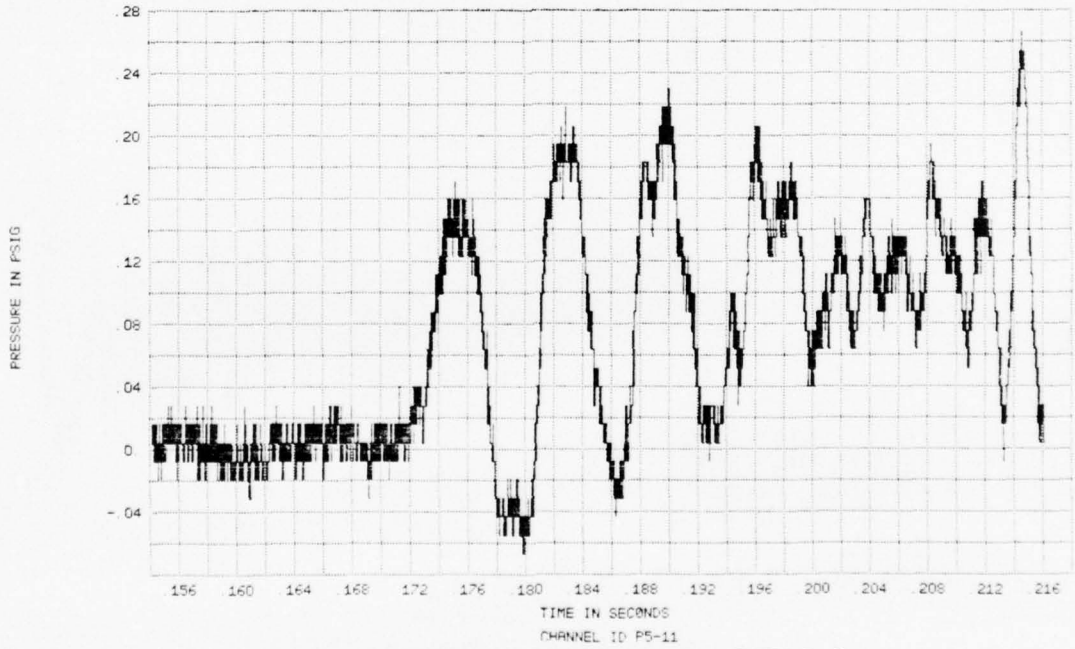


FIGURE 5-65 , SPECIMEN NO. 5 , SHOT NO. 5 ,
INTERNAL PRESSURE TIME HISTORY

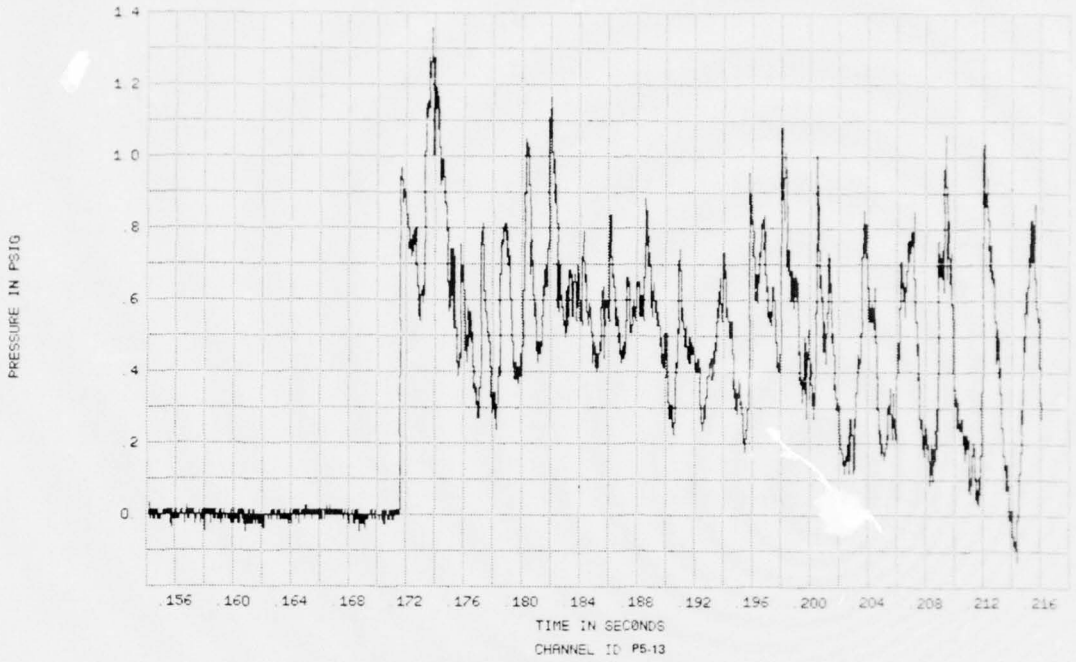


FIGURE 5-66 , SPECIMEN NO. 5 , SHOT NO. 5 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

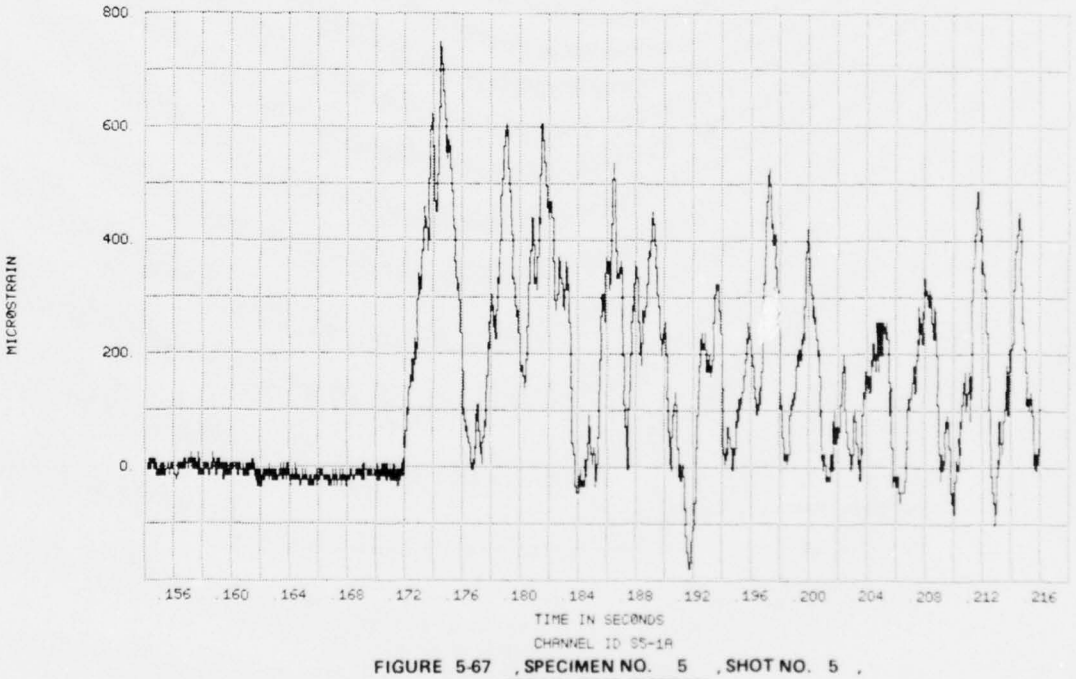


FIGURE 5-67 , SPECIMEN NO. 5 , SHOT NO. 5 ,
STRAIN TIME HISTORY

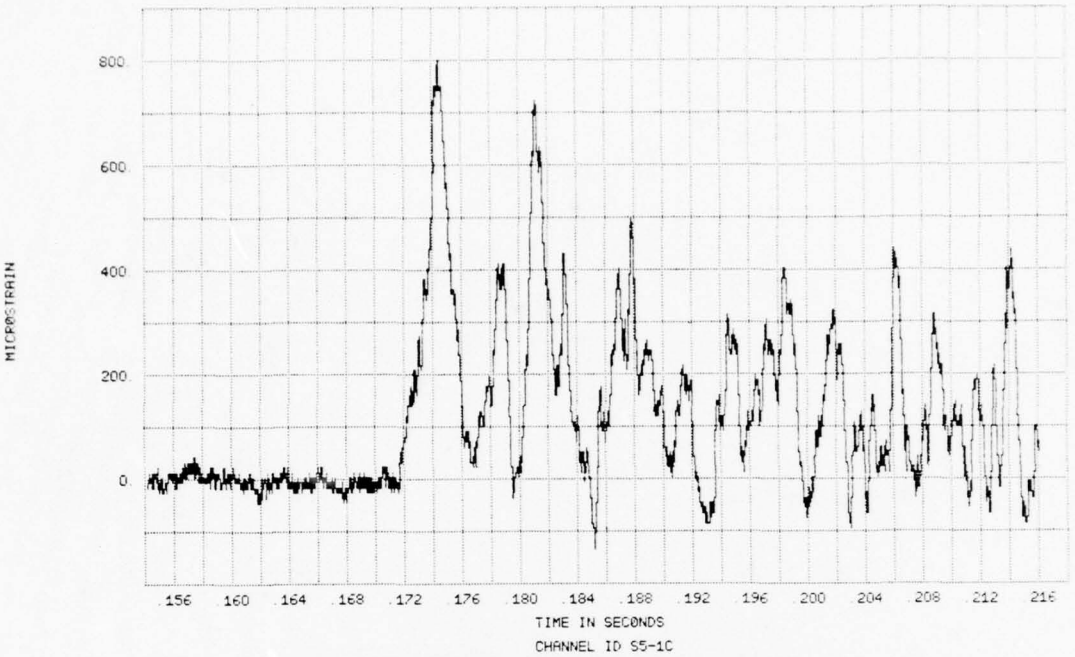


FIGURE 5-68 , SPECIMEN NO. 5 , SHOT NO. 5 , STRAIN TIME HISTORY

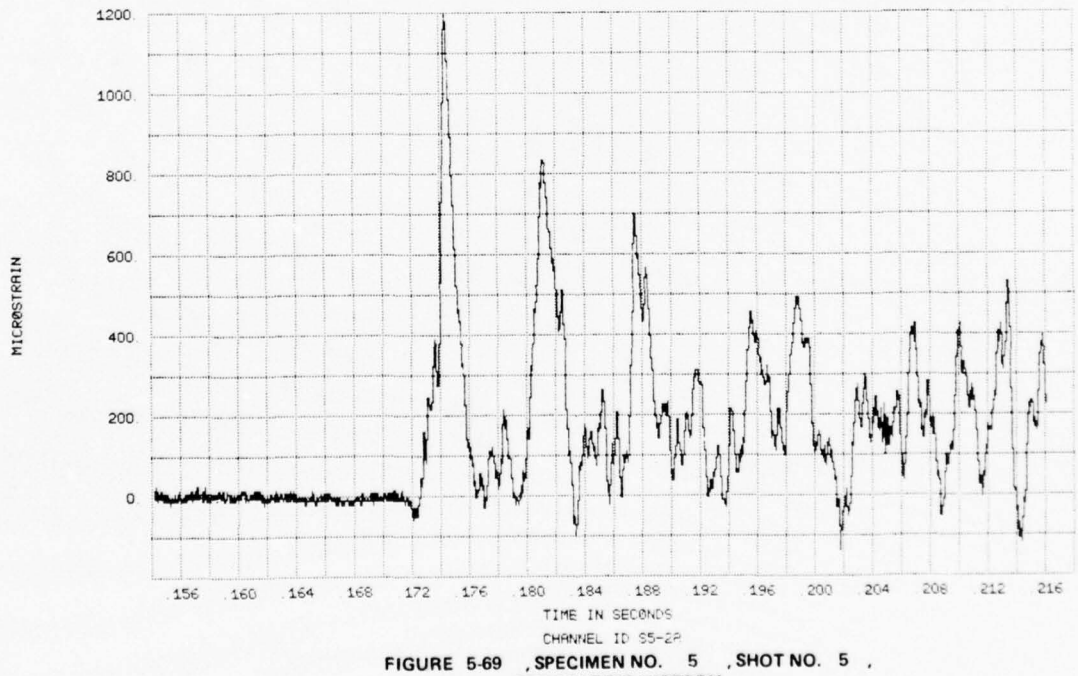


FIGURE 5-69 , SPECIMEN NO. 5 , SHOT NO. 5 , STRAIN TIME HISTORY

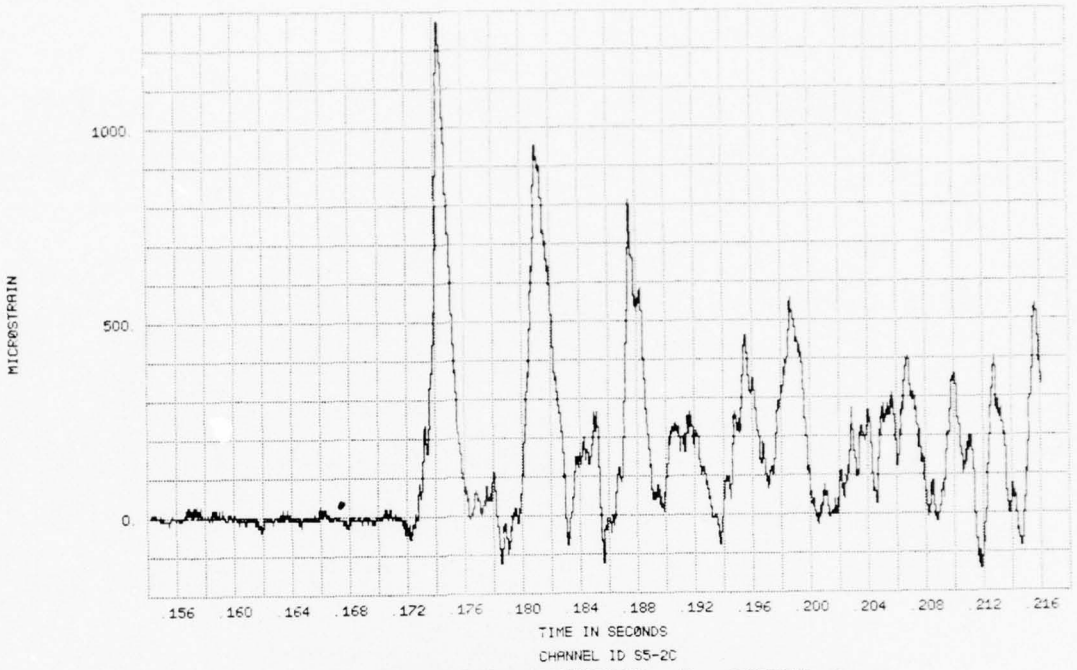


FIGURE 5-70 , SPECIMEN NO. 5 , SHOT NO. 5 , STRAIN TIME HISTORY

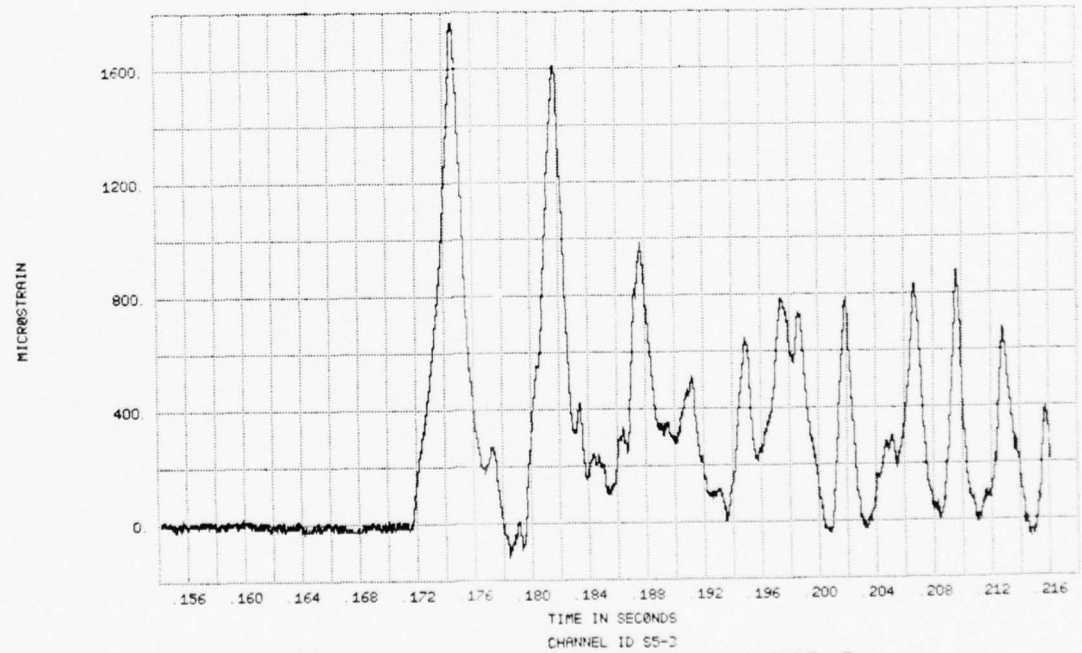


FIGURE 5-71 , SPECIMEN NO. 5 , SHOT NO. 5 , STRAIN TIME HISTORY

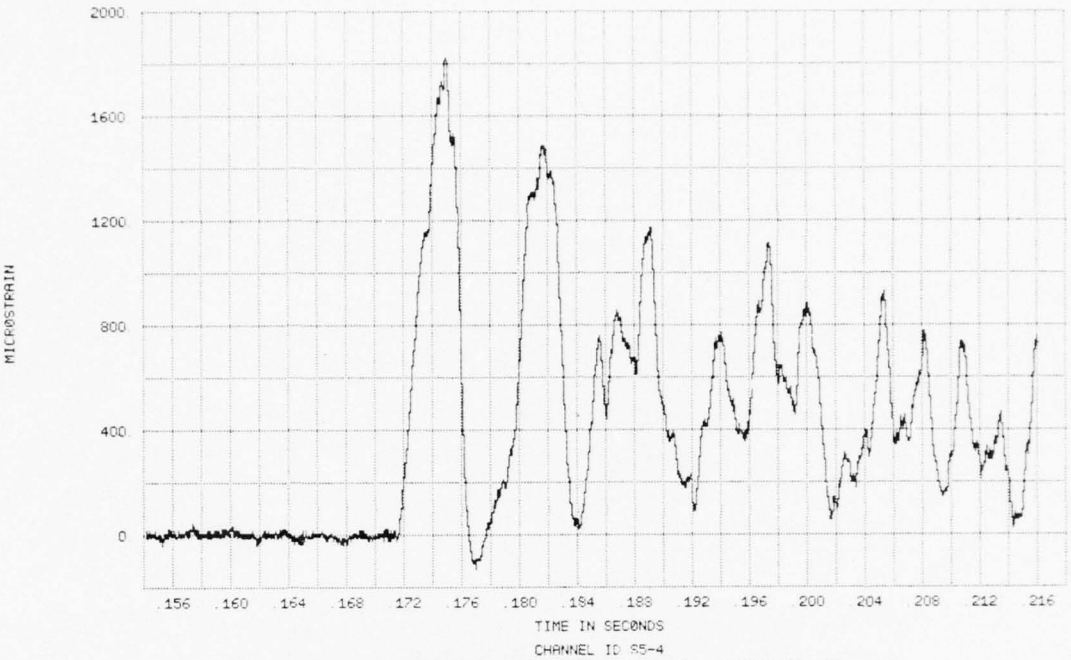


FIGURE 5-72 , SPECIMEN NO. 5 , SHOT NO. 5 ,
STRAIN TIME HISTORY

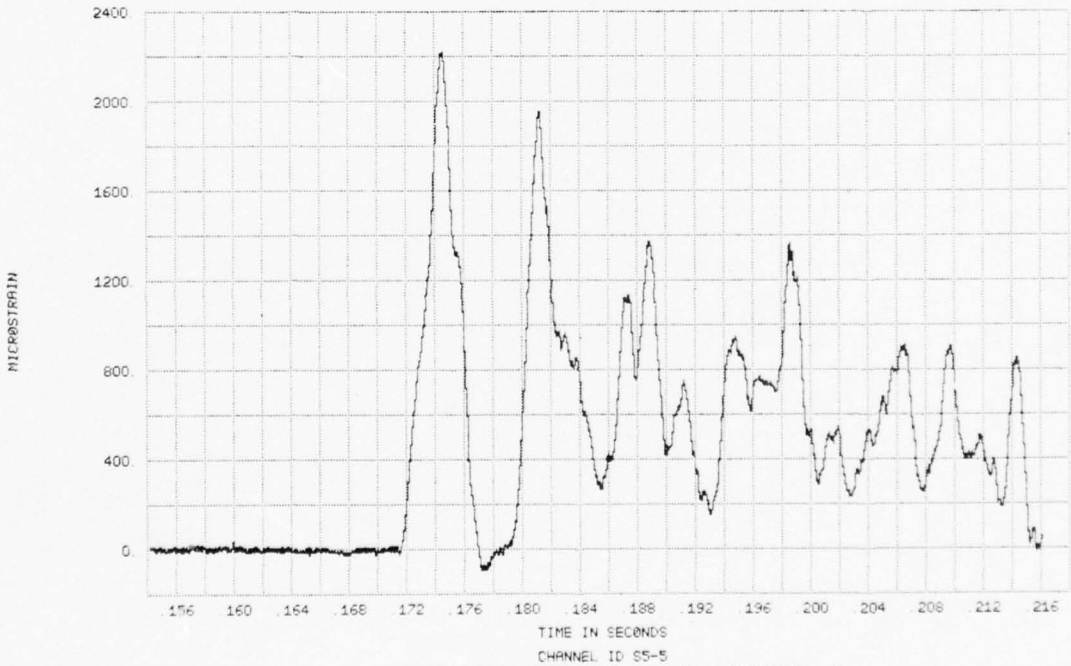


FIGURE 5-73 , SPECIMEN NO. 5 , SHOT NO. 5 ,
STRAIN TIME HISTORY

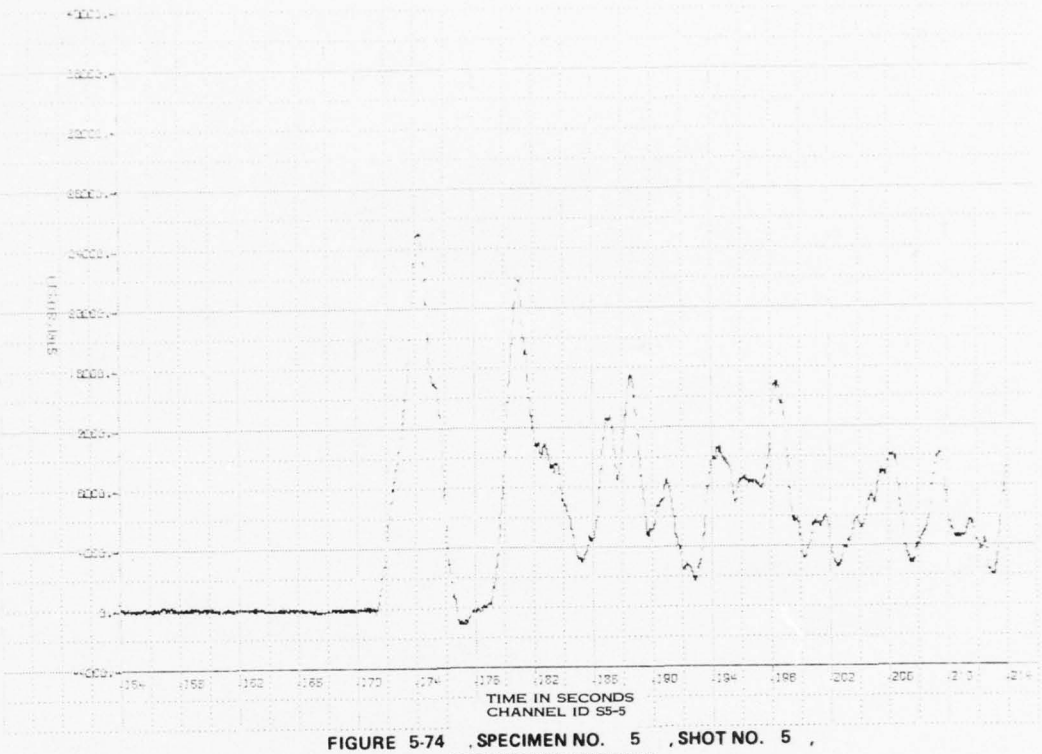


FIGURE 5-74 , SPECIMEN NO. 5 , SHOT NO. 5 ,
STRESS TIME HISTORY

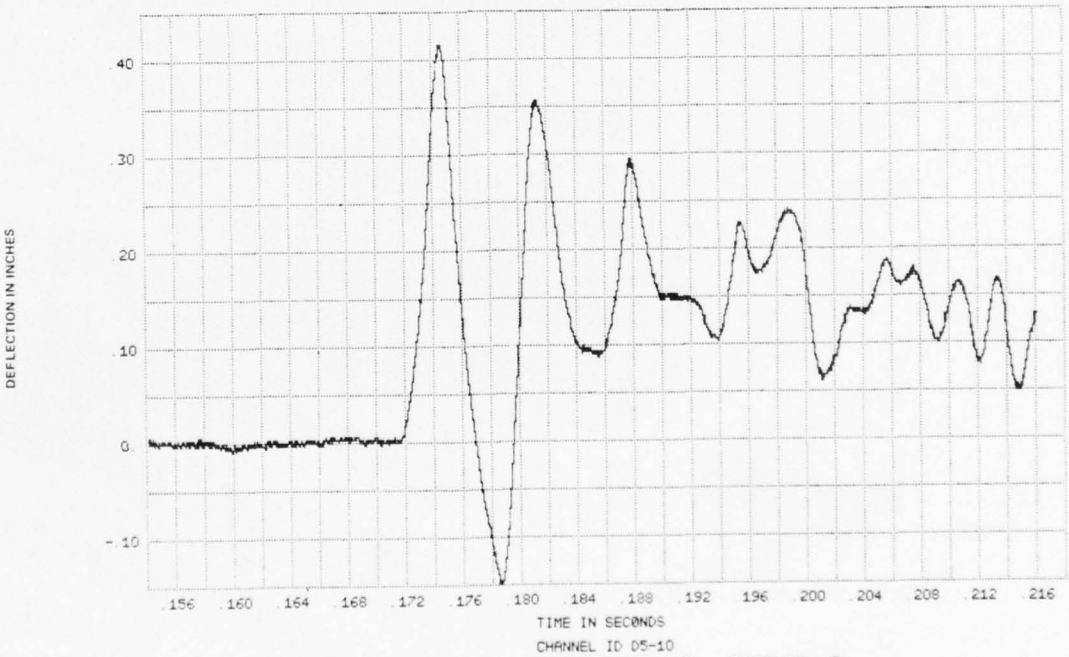


FIGURE 5-75 , SPECIMEN NO. 5 , SHOT NO. 5 ,
DEFLECTION TIME HISTORY

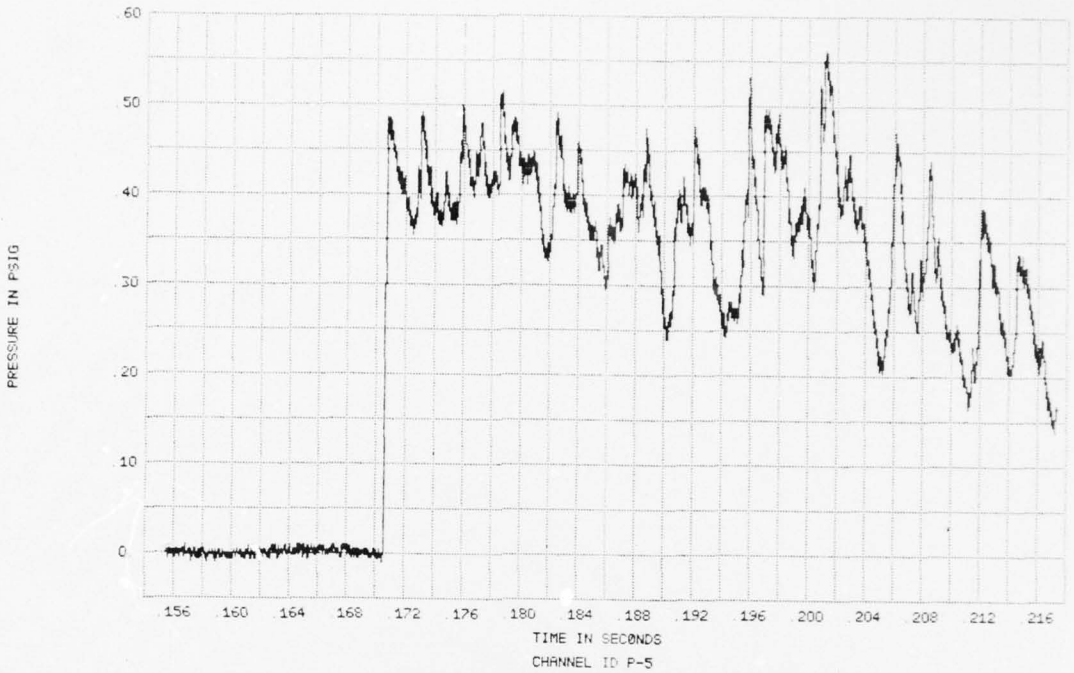


FIGURE 5-76 , SPECIMEN NO. 5 , SHOT NO. 6 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

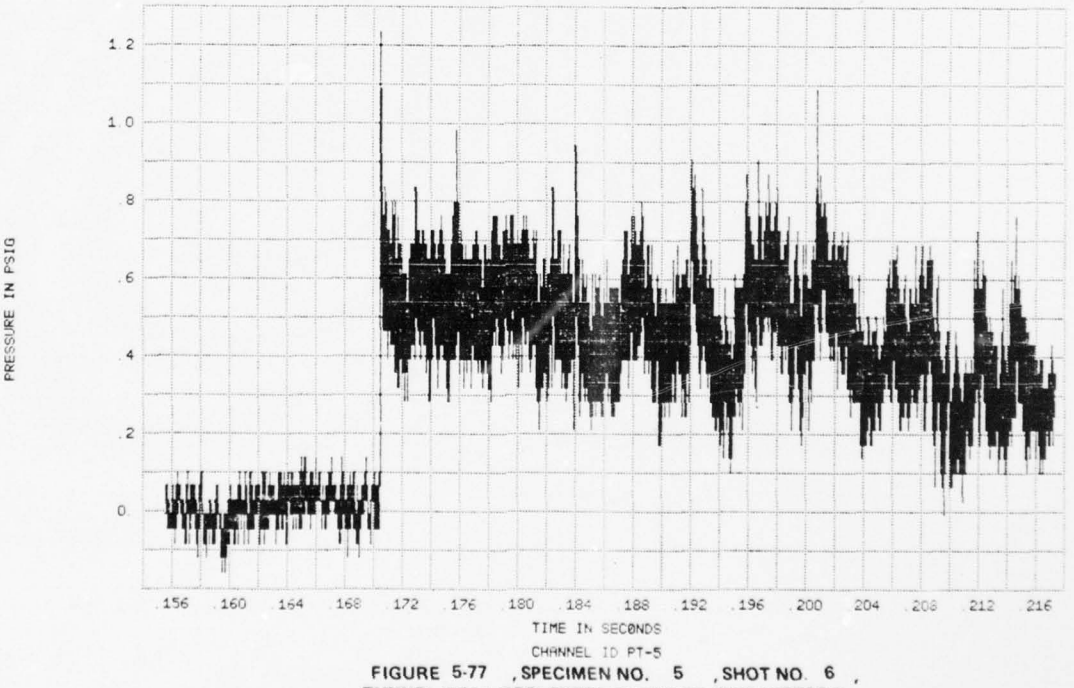


FIGURE 5-77 , SPECIMEN NO. 5 , SHOT NO. 6 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

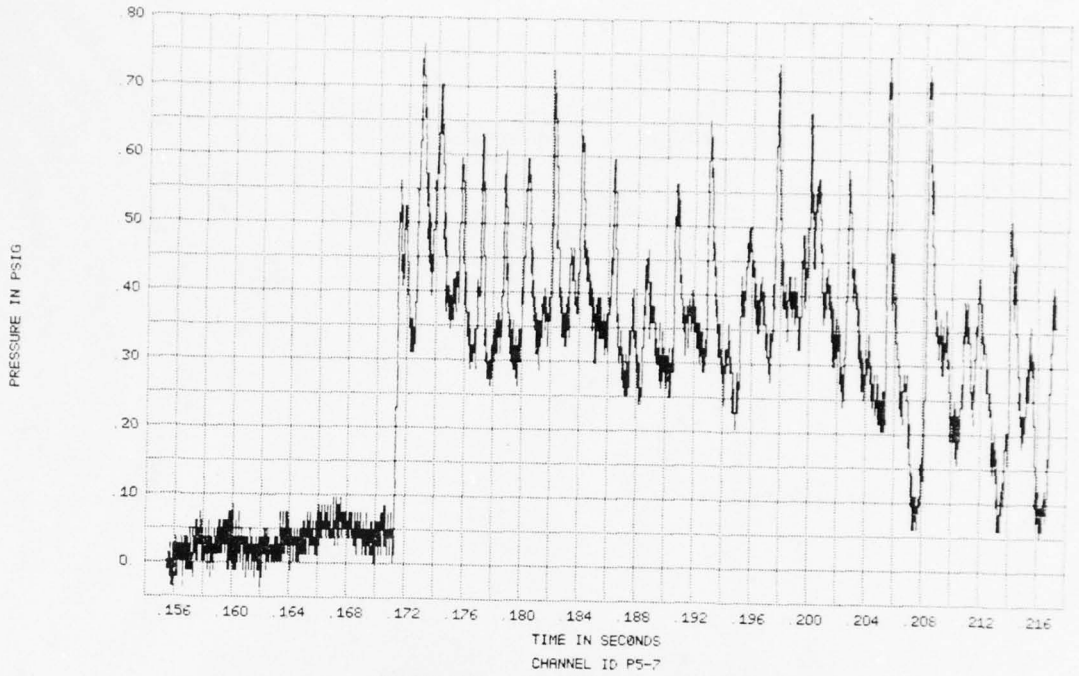


FIGURE 5-78 , SPECIMEN NO. 5 , SHOT NO. 6 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

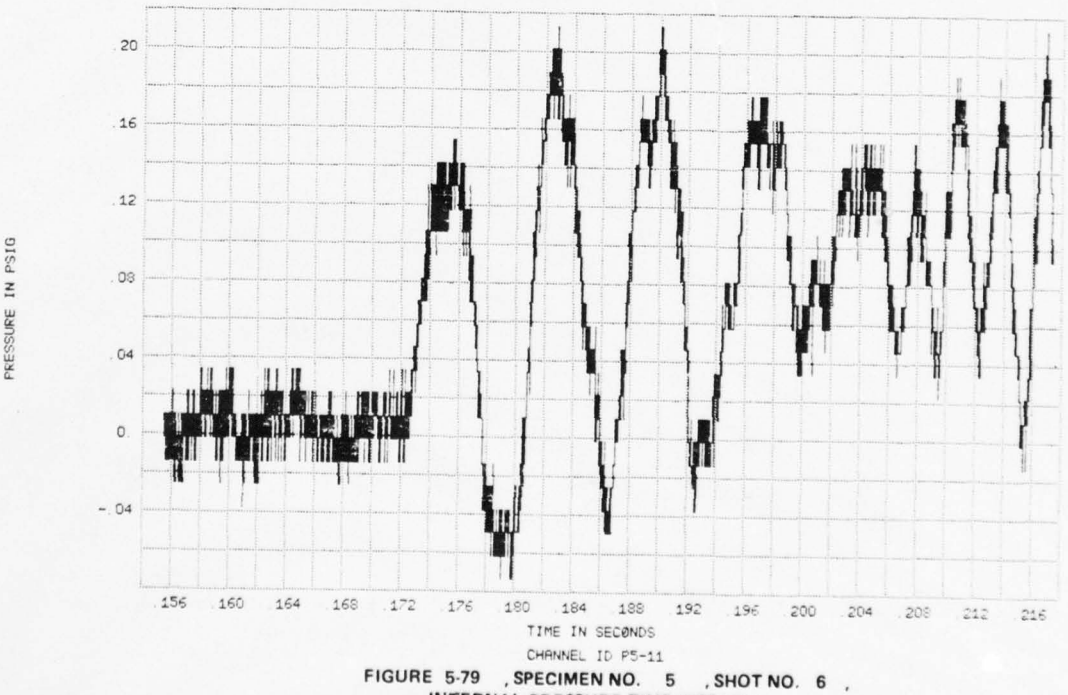


FIGURE 5-79 , SPECIMEN NO. 5 , SHOT NO. 6 ,
INTERNAL PRESSURE TIME HISTORY

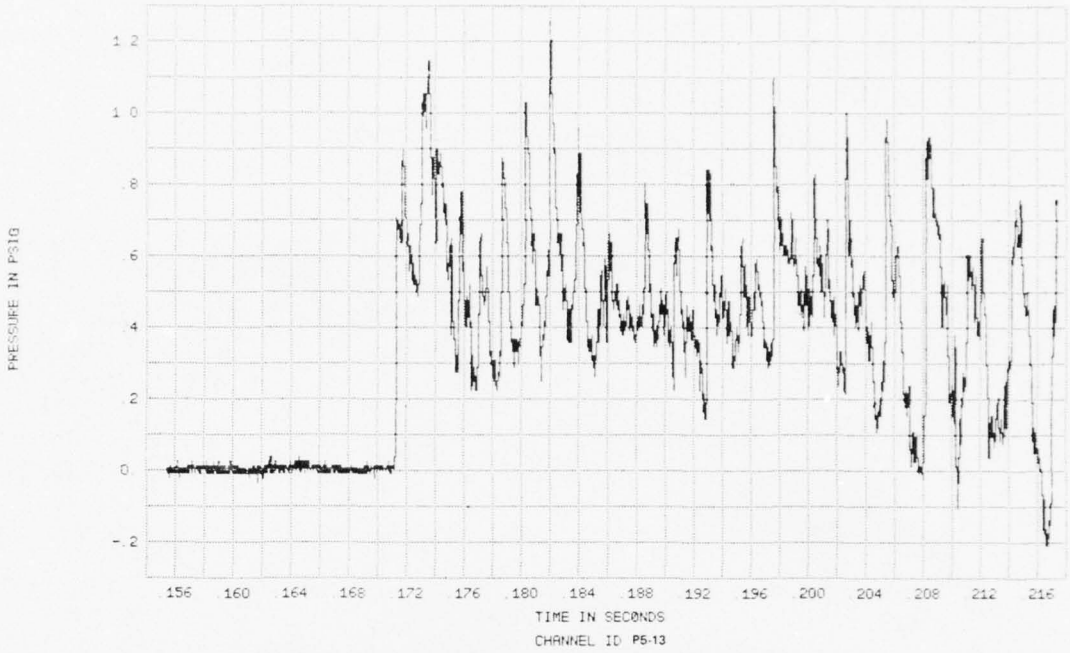


FIGURE 5-80 , SPECIMEN NO. 5 , SHOT NO. 6 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

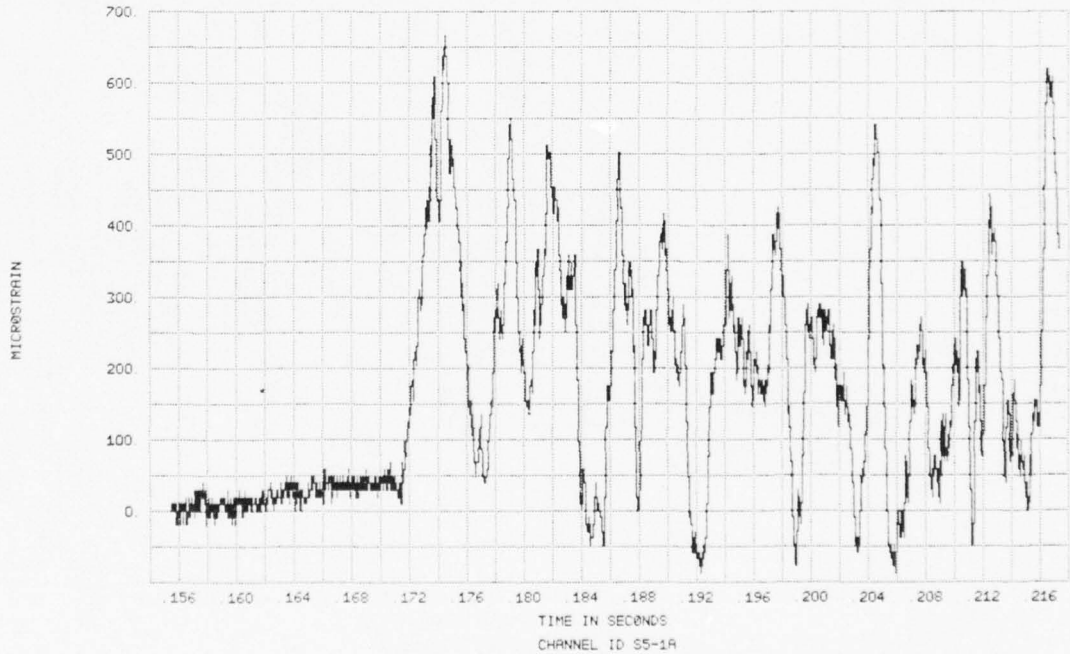


FIGURE 5-81 , SPECIMEN NO. 5 , SHOT NO. 6 ,
STRAIN TIME HISTORY

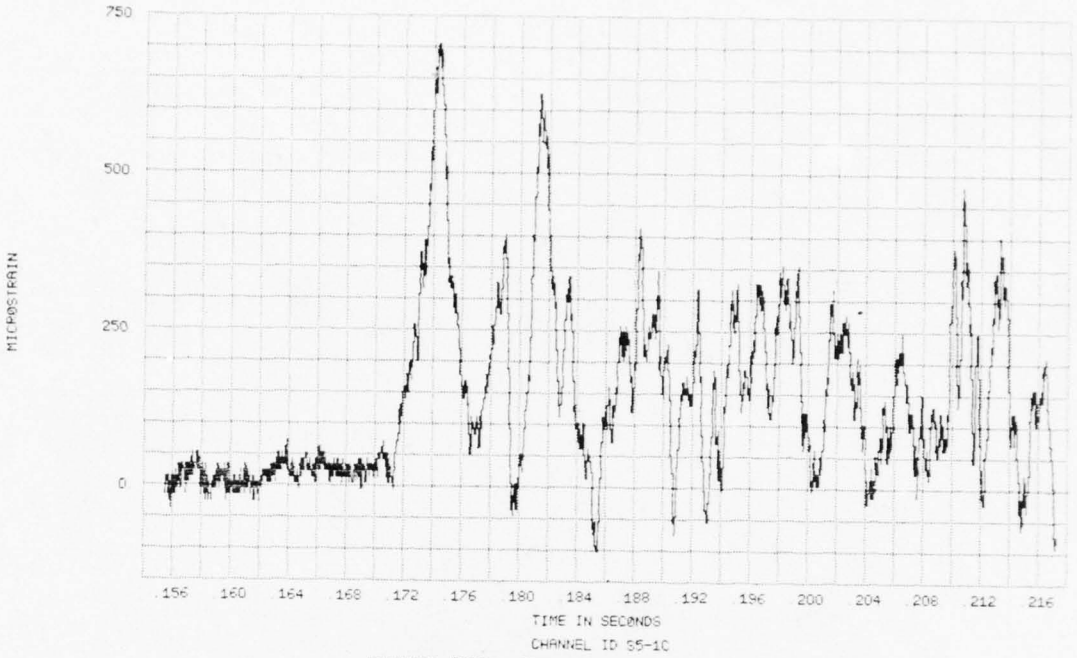


FIGURE 5-82 , SPECIMEN NO. 5 , SHOT NO. 6 ,
STRAIN TIME HISTORY

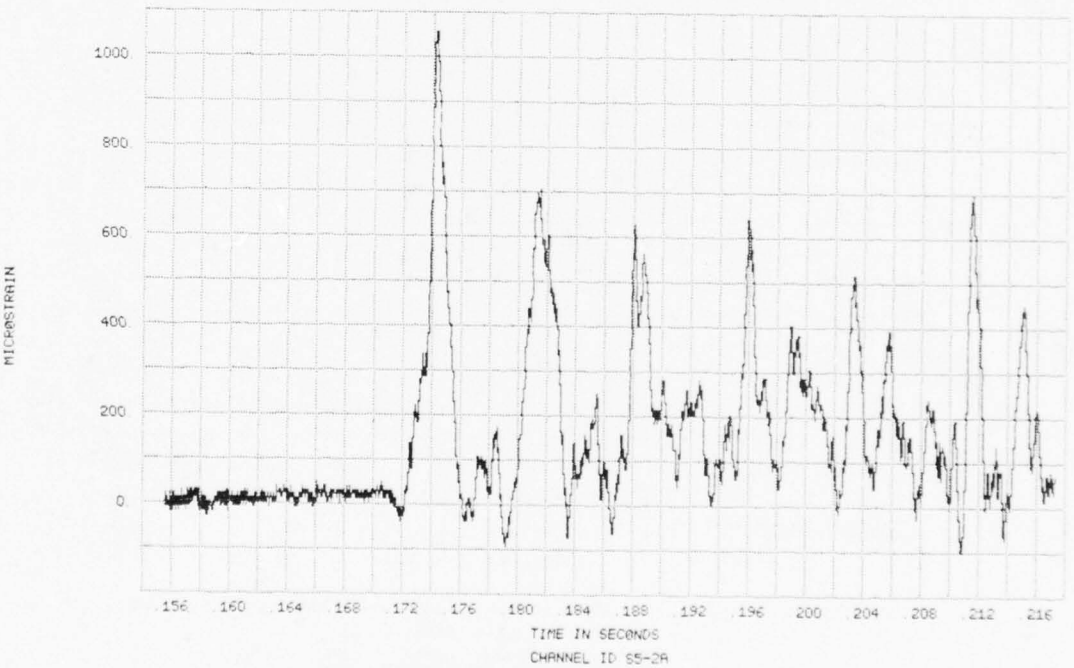


FIGURE 5-83 , SPECIMEN NO. 5 , SHOT NO. 6 ,
STRAIN TIME HISTORY

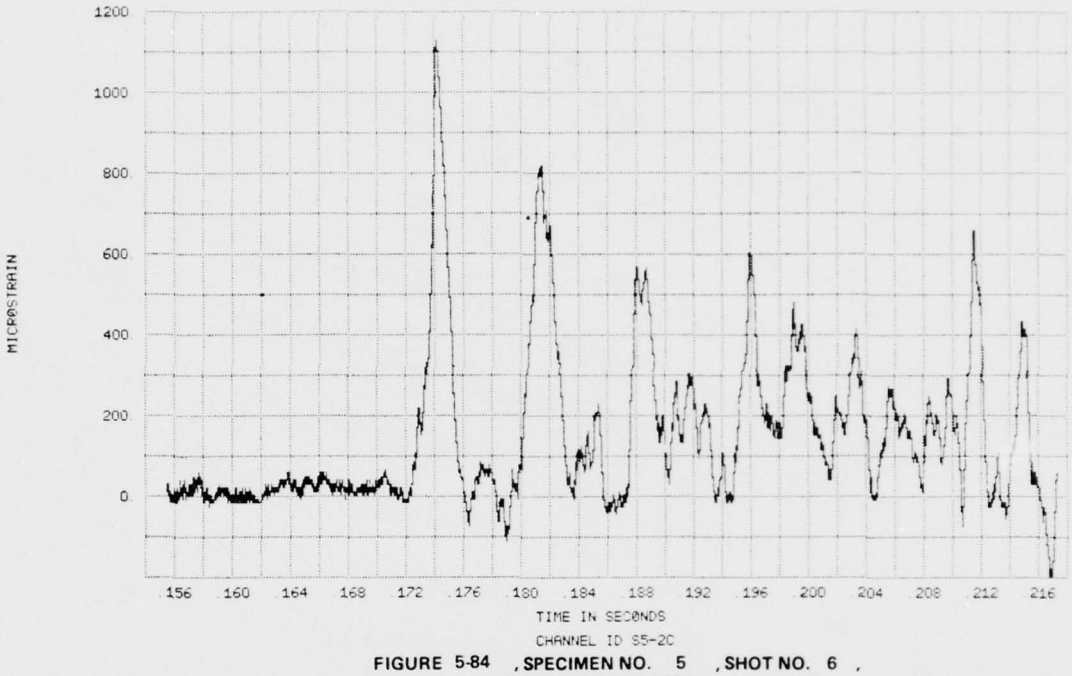


FIGURE 5-84 , SPECIMEN NO. 5 , SHOT NO. 6 ,
STRAIN TIME HISTORY

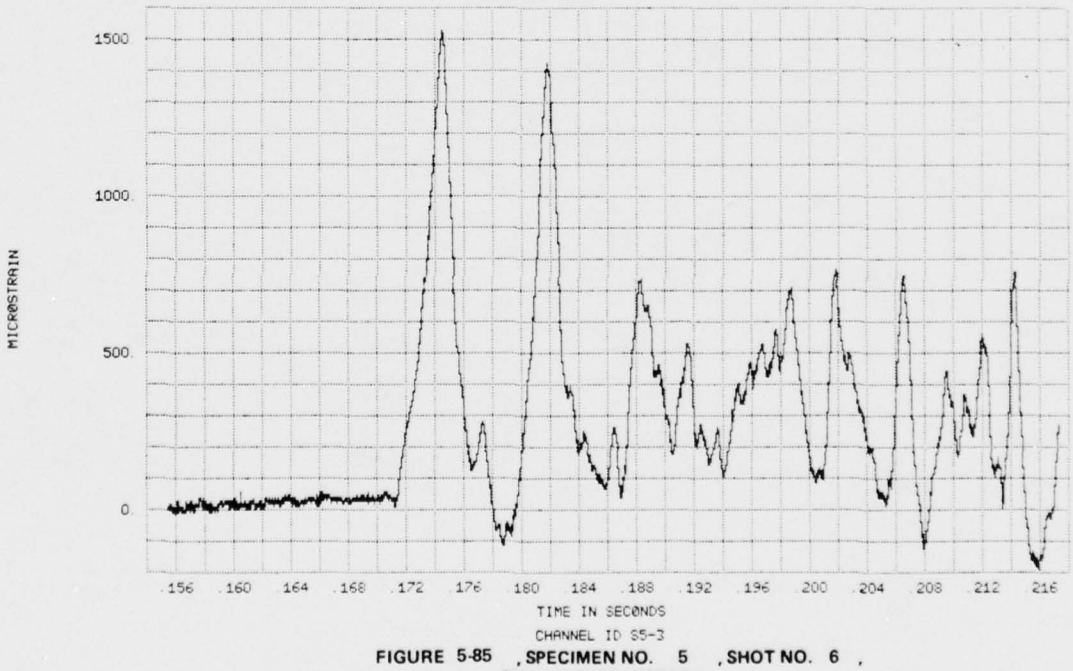


FIGURE 5-85 , SPECIMEN NO. 5 , SHOT NO. 6 ,
STRAIN TIME HISTORY

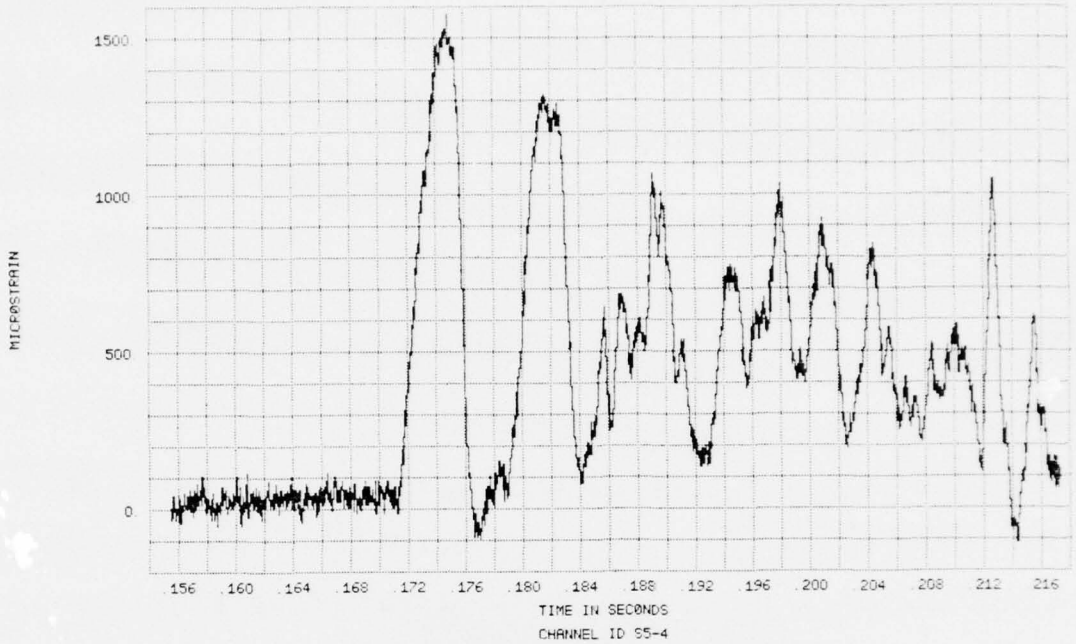


FIGURE 5-86 , SPECIMEN NO. 5 , SHOT NO. 6 , STRAIN TIME HISTORY

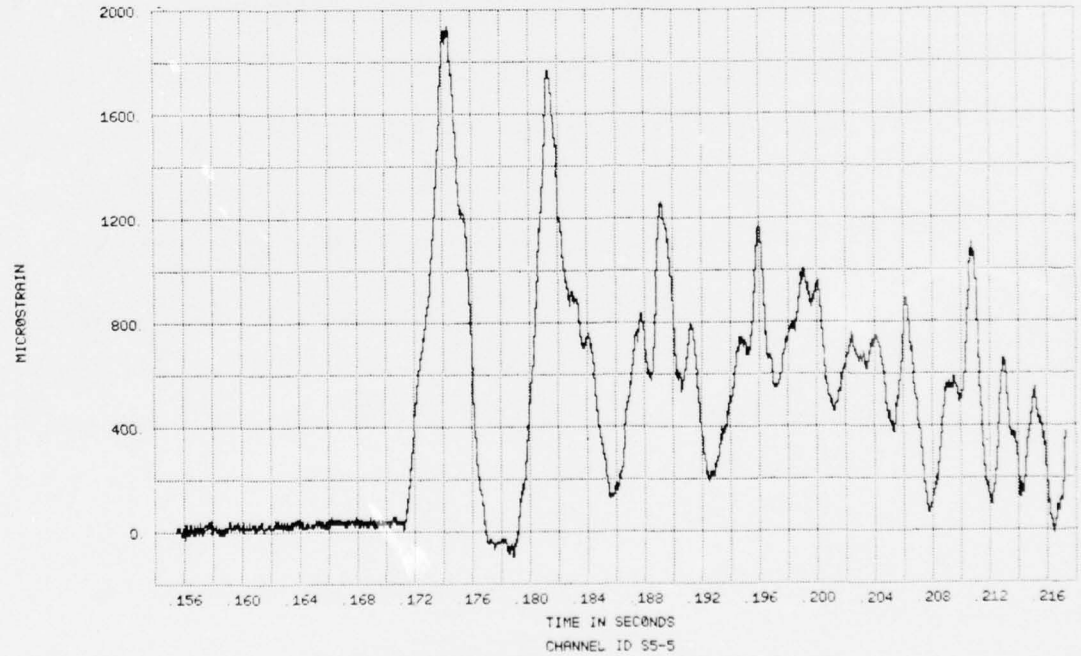


FIGURE 5-87 , SPECIMEN NO. 5 , SHOT NO. 6 , STRAIN TIME HISTORY

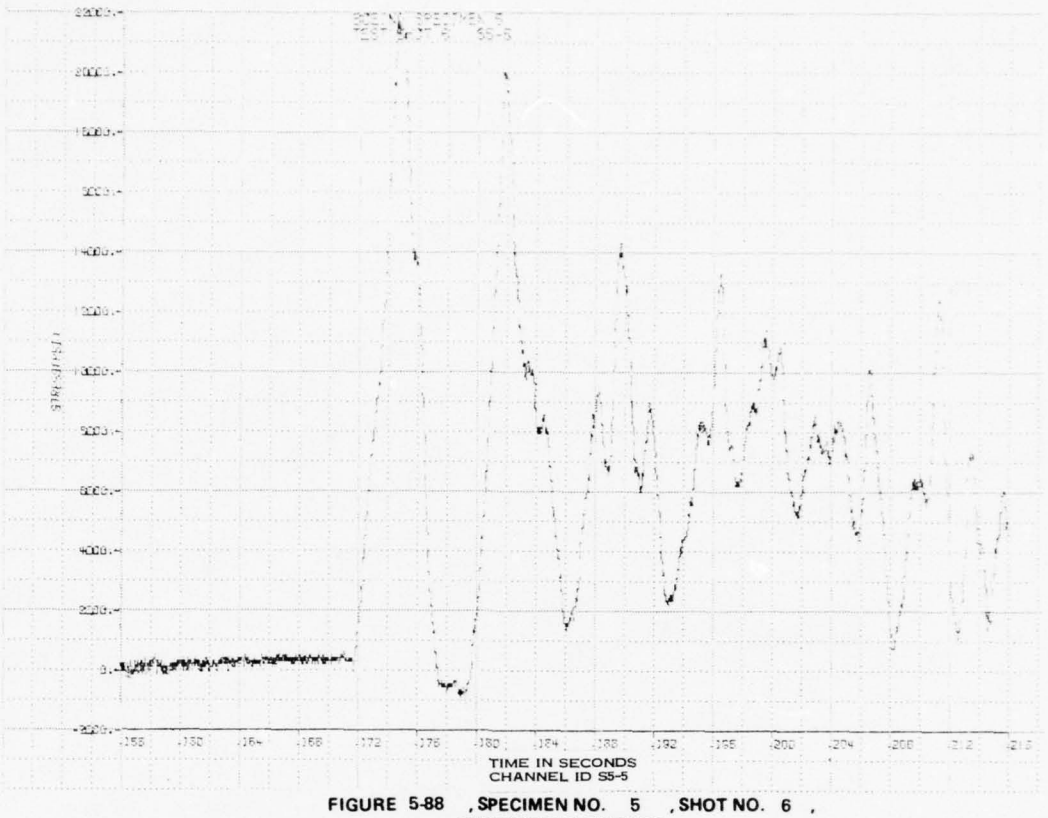


FIGURE 5-88 , SPECIMEN NO. 5 , SHOT NO. 6 ,
STRESS TIME HISTORY

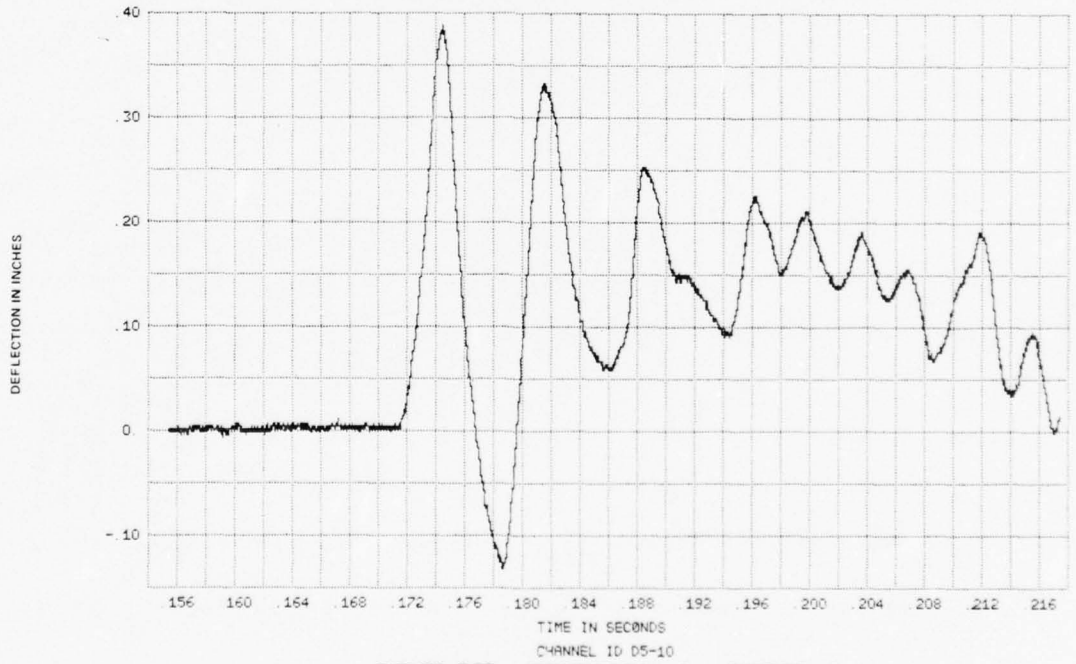


FIGURE 5-89 , SPECIMEN NO. 5 , SHOT NO. 6 ,
DEFLECTION TIME HISTORY

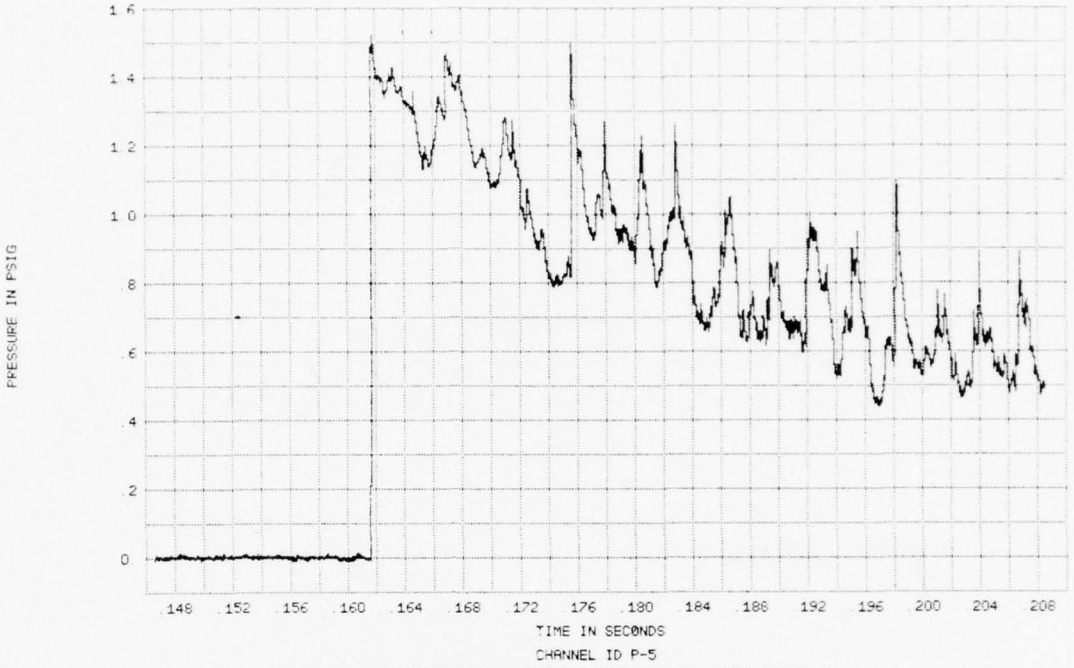


FIGURE 5-90 , SPECIMEN NO. 5 , SHOT NO. 8 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

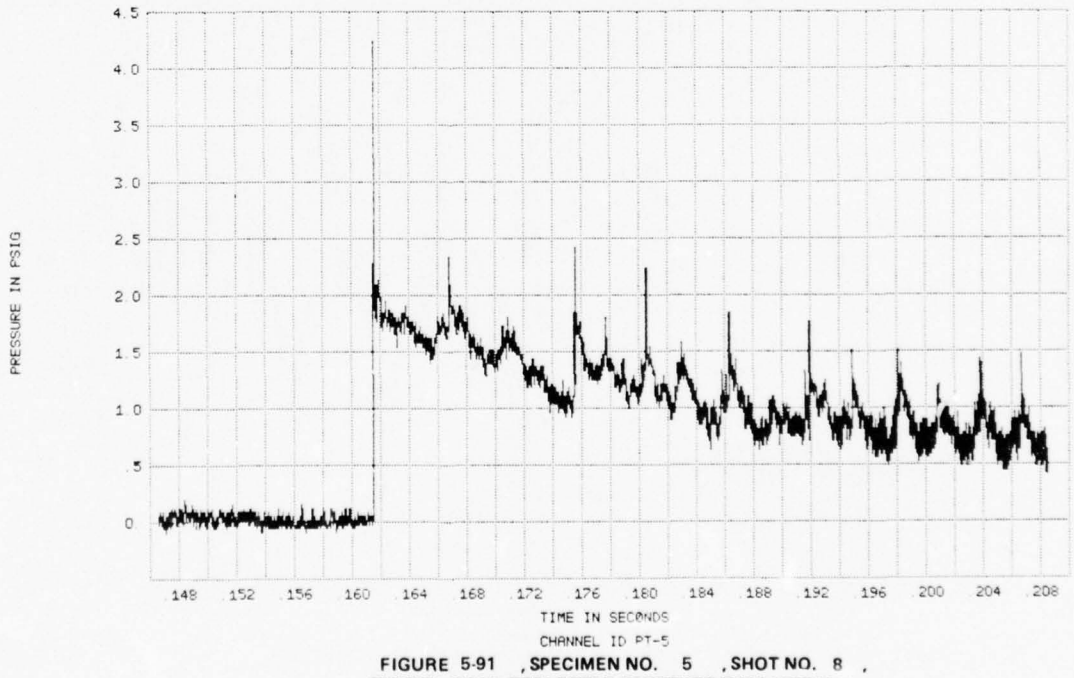


FIGURE 5-91 , SPECIMEN NO. 5 , SHOT NO. 8 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

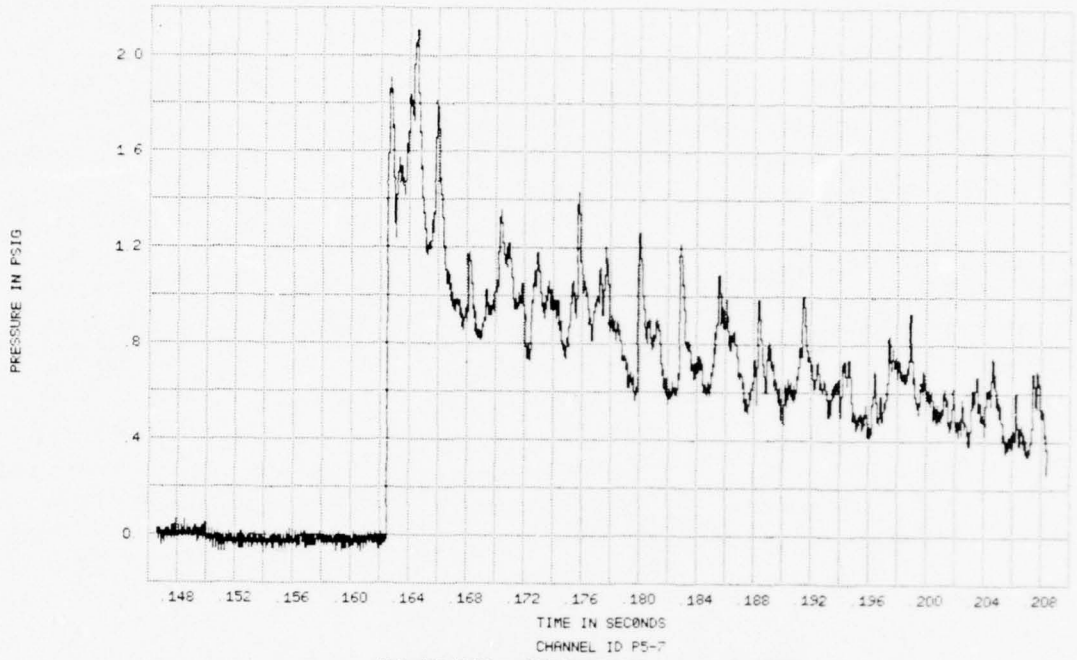


FIGURE 5-92 , SPECIMEN NO. 5 , SHOT NO. 8 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

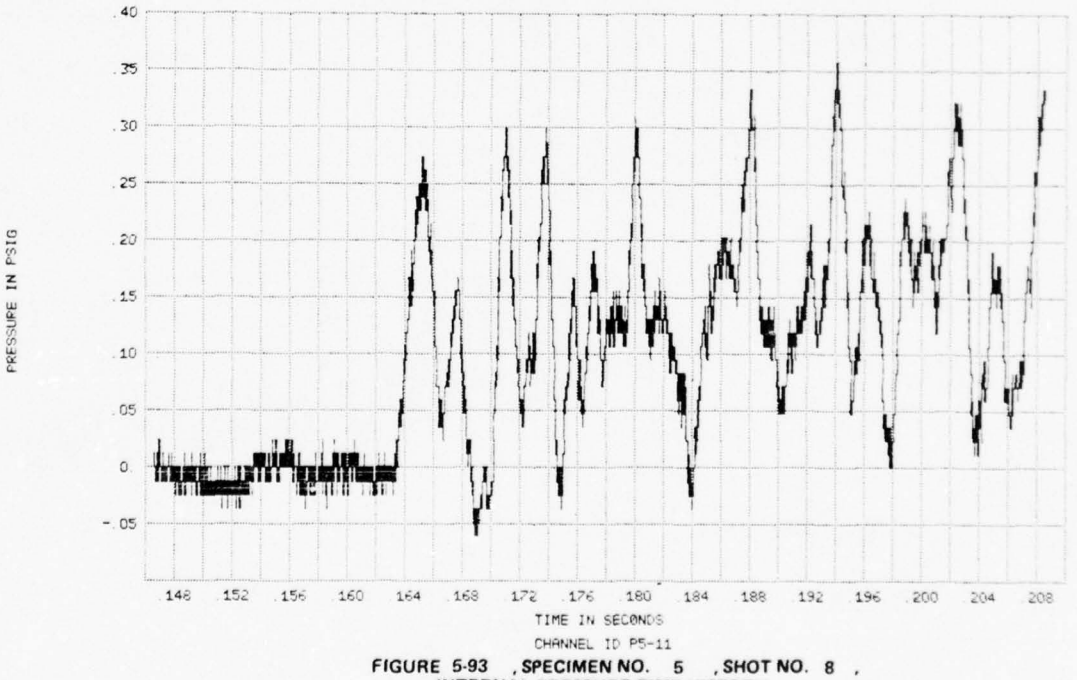


FIGURE 5-93 , SPECIMEN NO. 5 , SHOT NO. 8 ,
INTERNAL PRESSURE TIME HISTORY

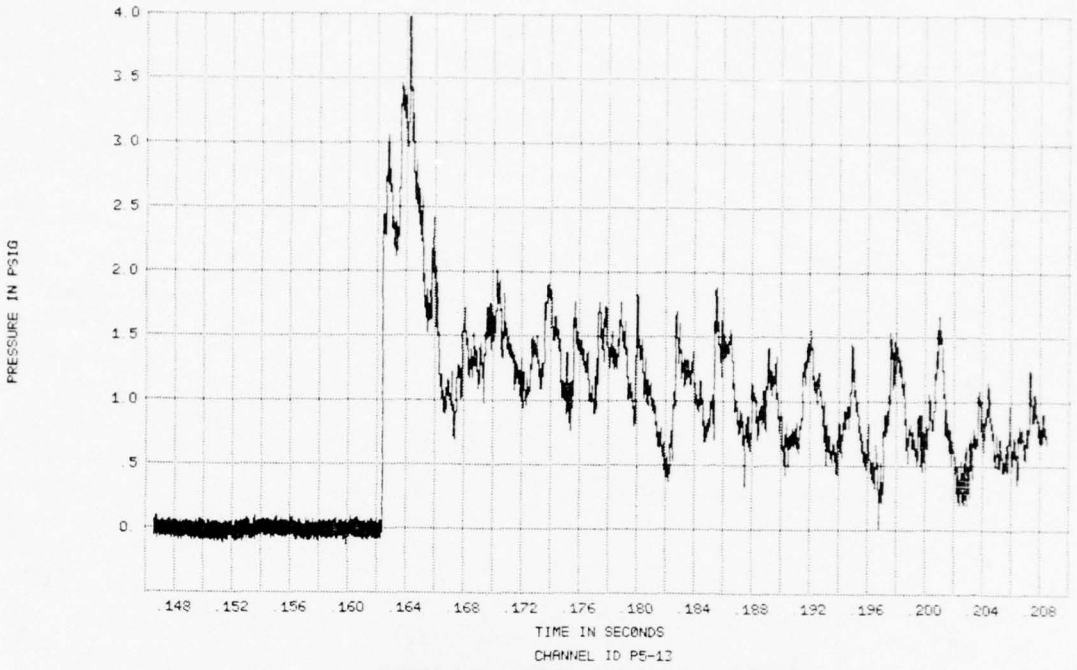


FIGURE 5-94 , SPECIMEN NO. 5 , SHOT NO. 8 , SPECIMEN REFLECTED PRESSURE TIME HISTORY

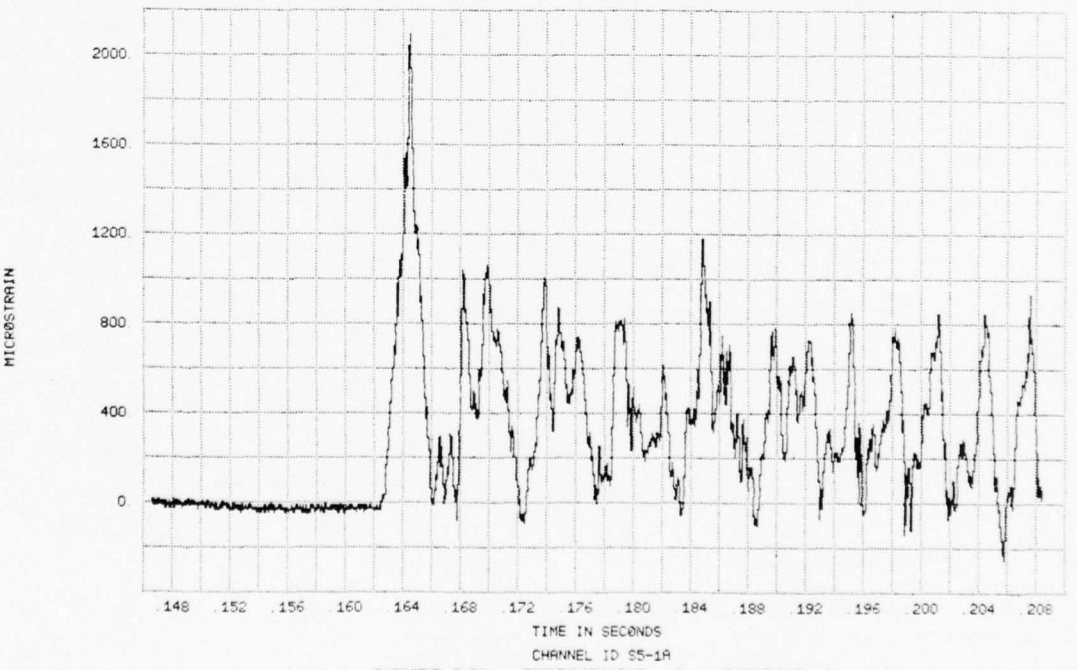


FIGURE 5-95 , SPECIMEN NO. 5 , SHOT NO. 8 , STRAIN TIME HISTORY

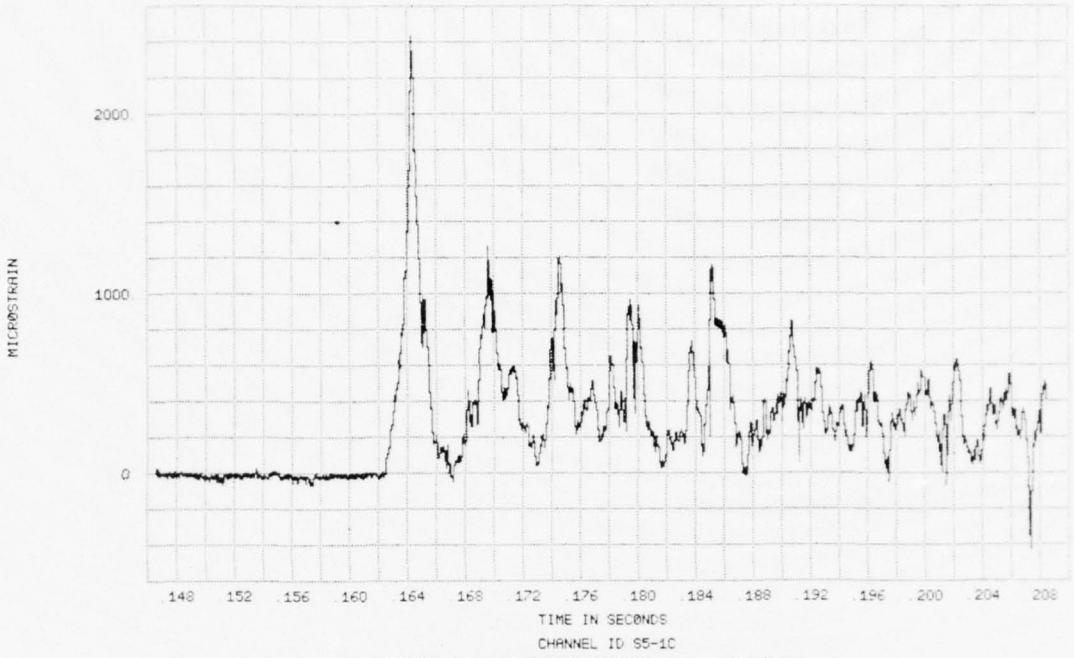


FIGURE 5-96 , SPECIMEN NO. 5 , SHOT NO. 8 ,
STRAIN TIME HISTORY

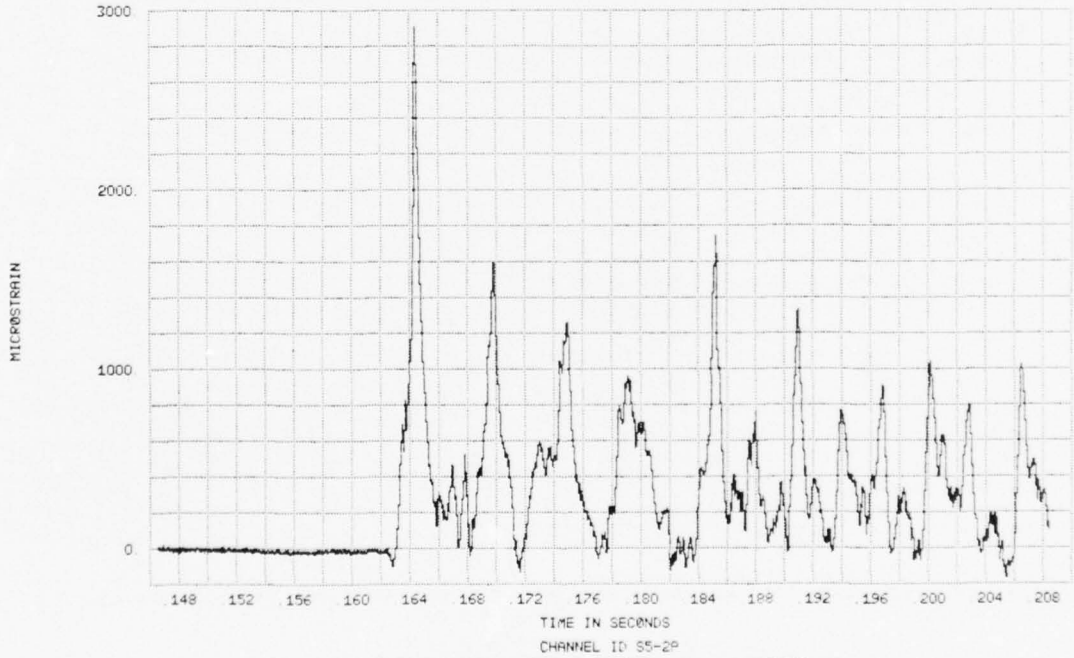


FIGURE 5-97 , SPECIMEN NO. 5 , SHOT NO. 8 ,
STRAIN TIME HISTORY

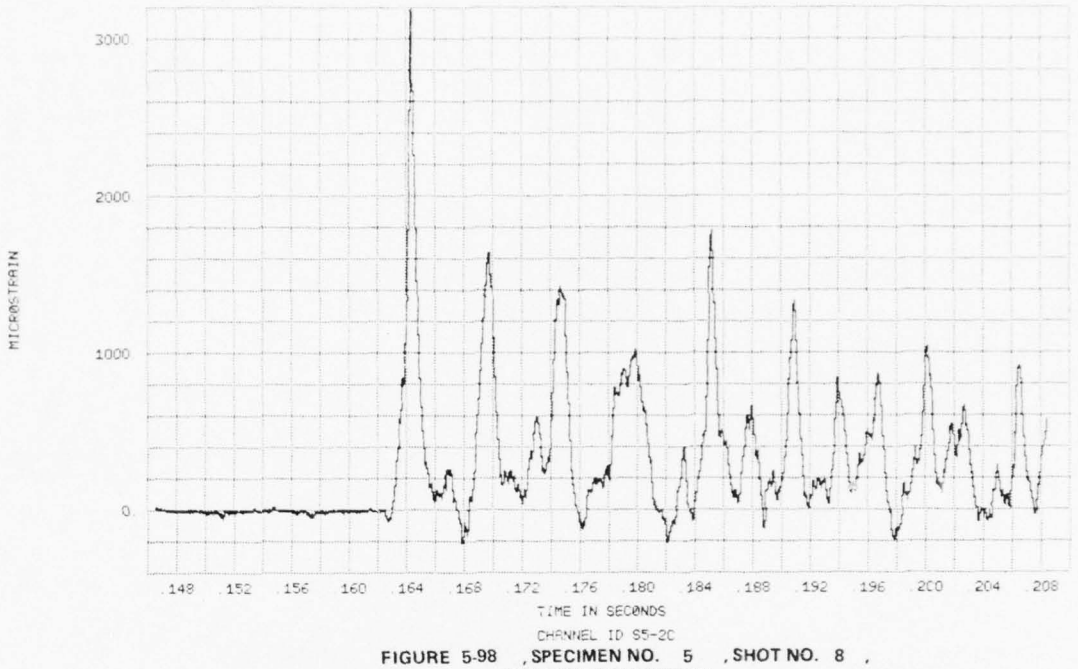


FIGURE 5-98 , SPECIMEN NO. 5 , SHOT NO. 8 ,
STRAIN TIME HISTORY

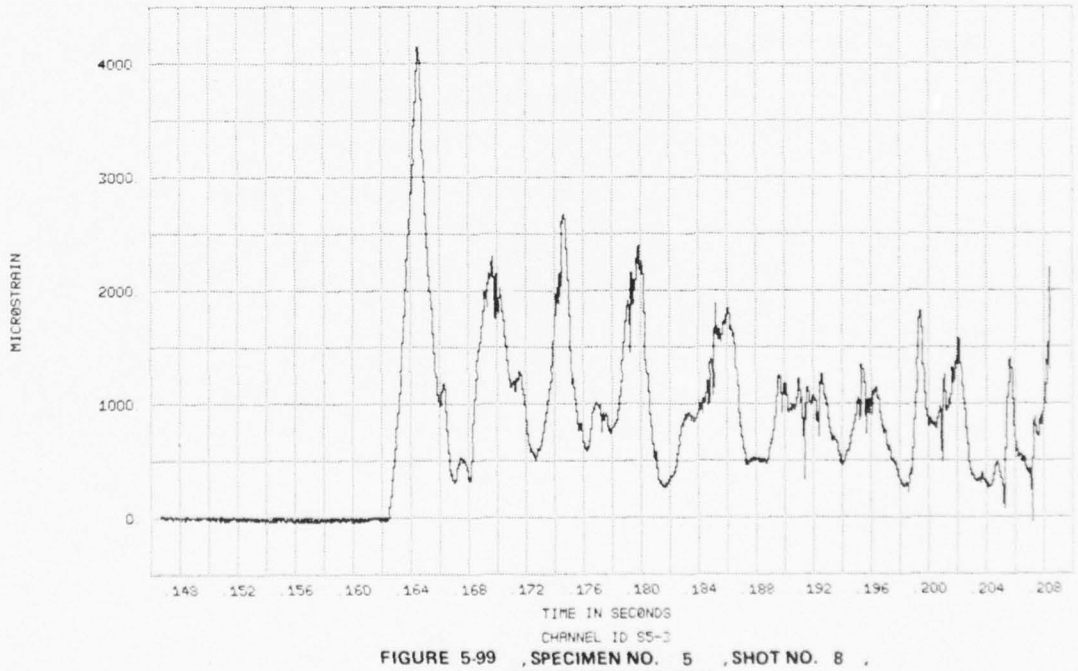


FIGURE 5-99 , SPECIMEN NO. 5 , SHOT NO. 8 ,
STRAIN TIME HISTORY

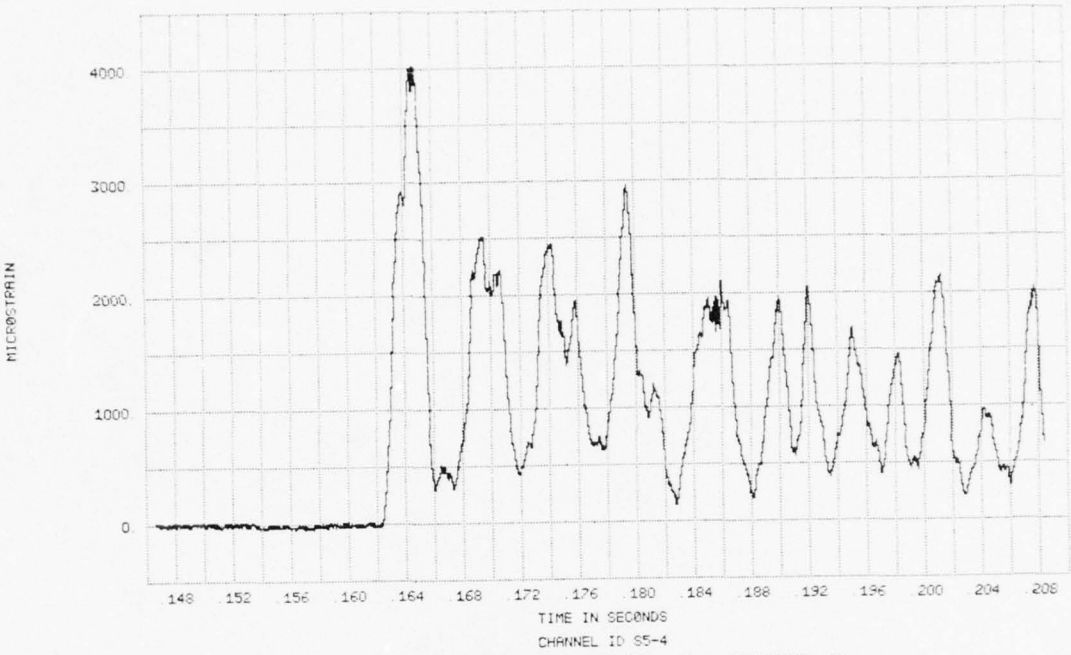


FIGURE 5-100 , SPECIMEN NO. 5 , SHOT NO. 8 ,
STRAIN TIME HISTORY

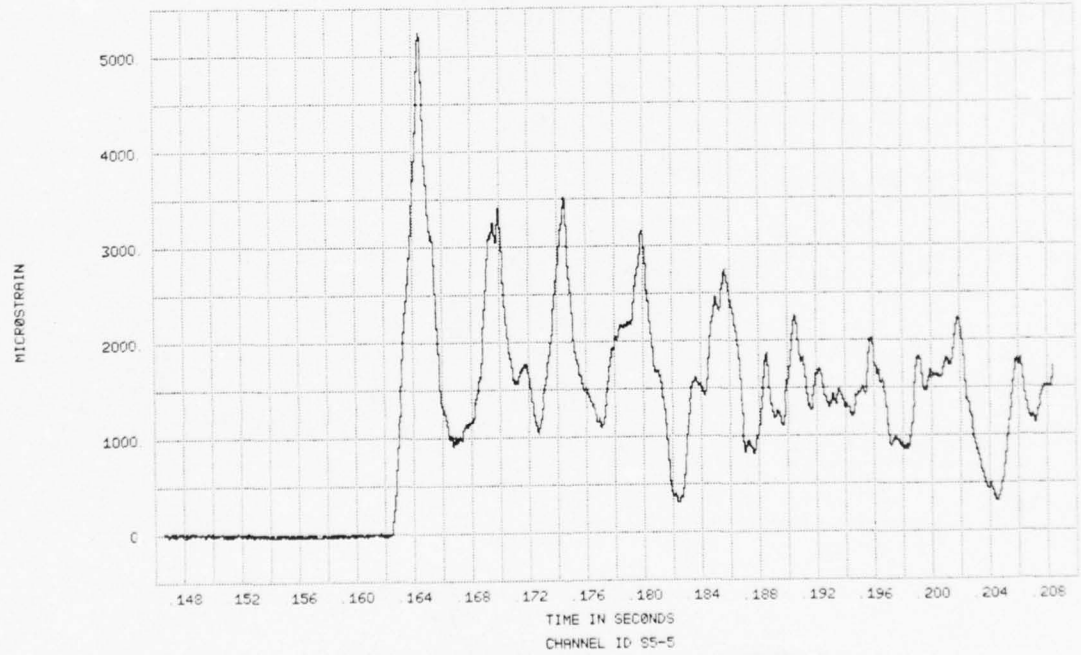


FIGURE 5-101 , SPECIMEN NO. 5 , SHOT NO. 8 ,
STRAIN TIME HISTORY

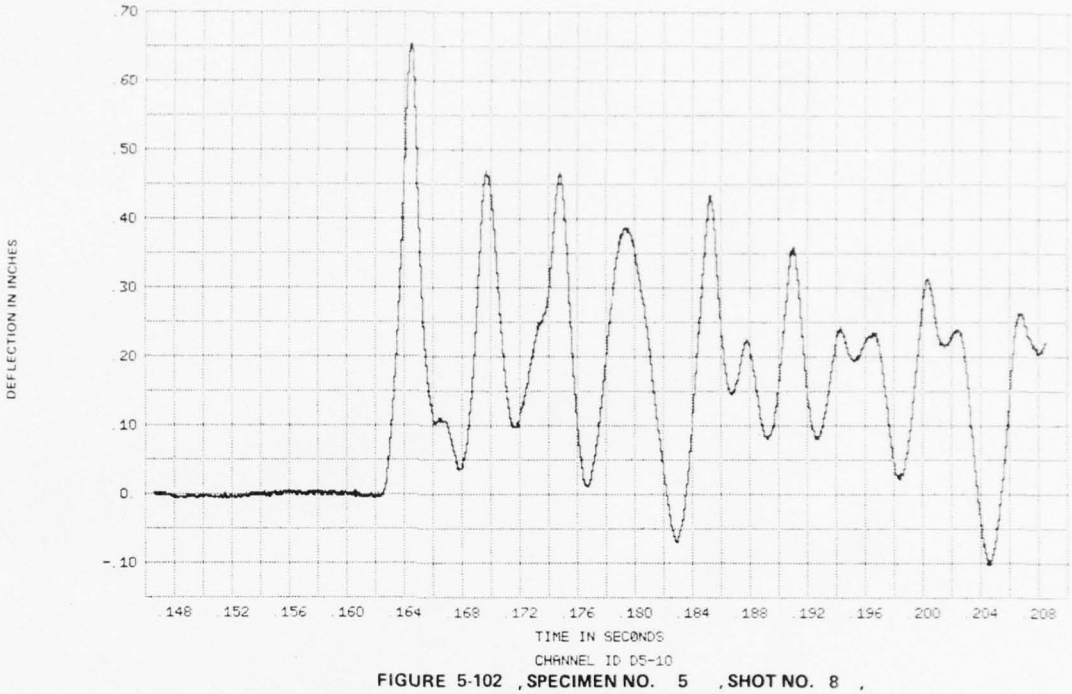


FIGURE 5-102 , SPECIMEN NO. 5 , SHOT NO. 8 ,
DEFLECTION TIME HISTORY

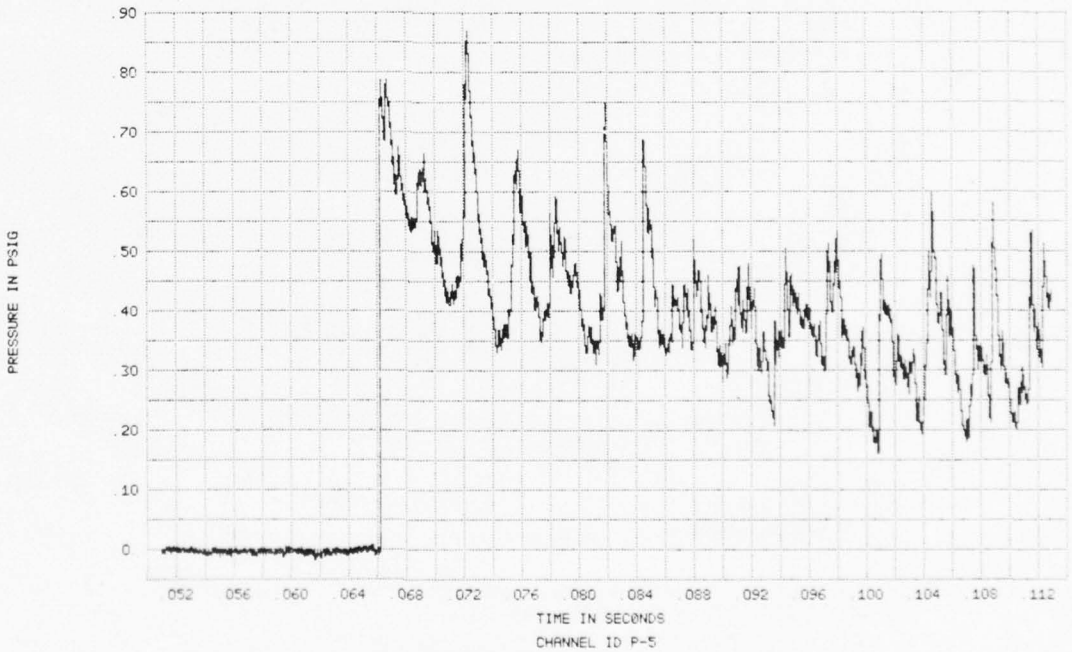


FIGURE 5-103 , SPECIMEN NO. 5 , SHOT NO. 9 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

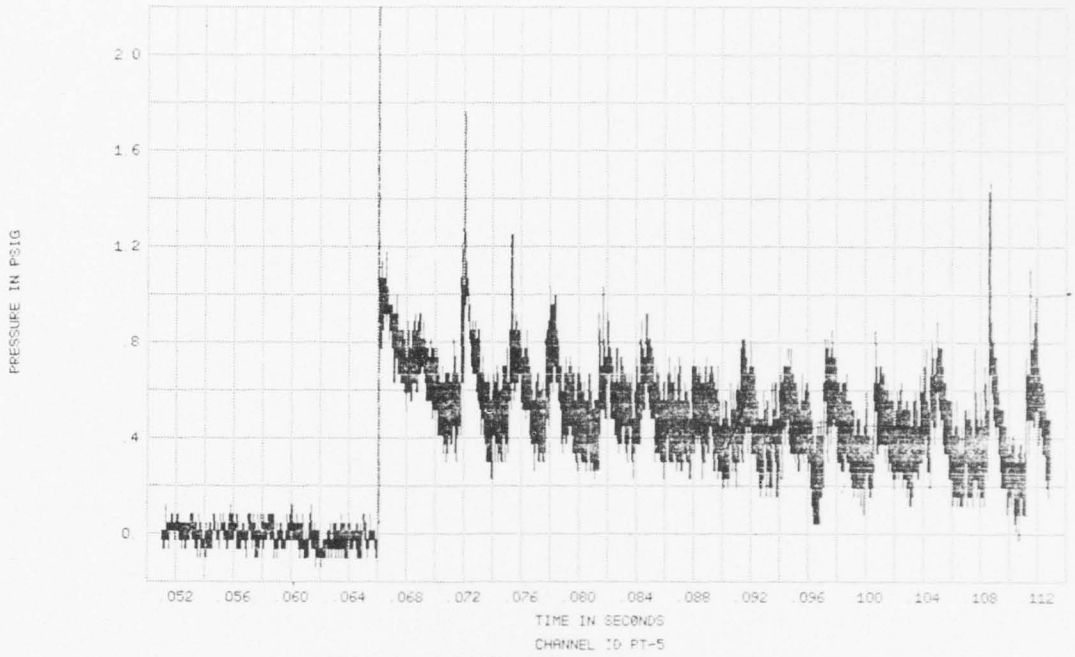


FIGURE 5-104 , SPECIMEN NO. 5 , SHOT NO. 9 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

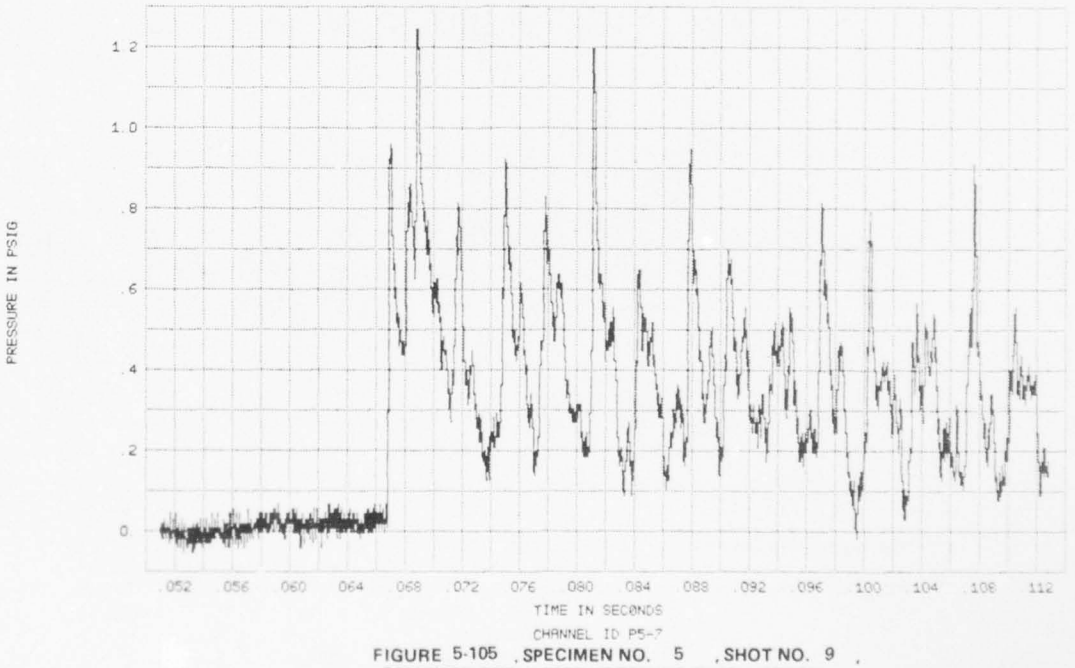


FIGURE 5-105 , SPECIMEN NO. 5 , SHOT NO. 9 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

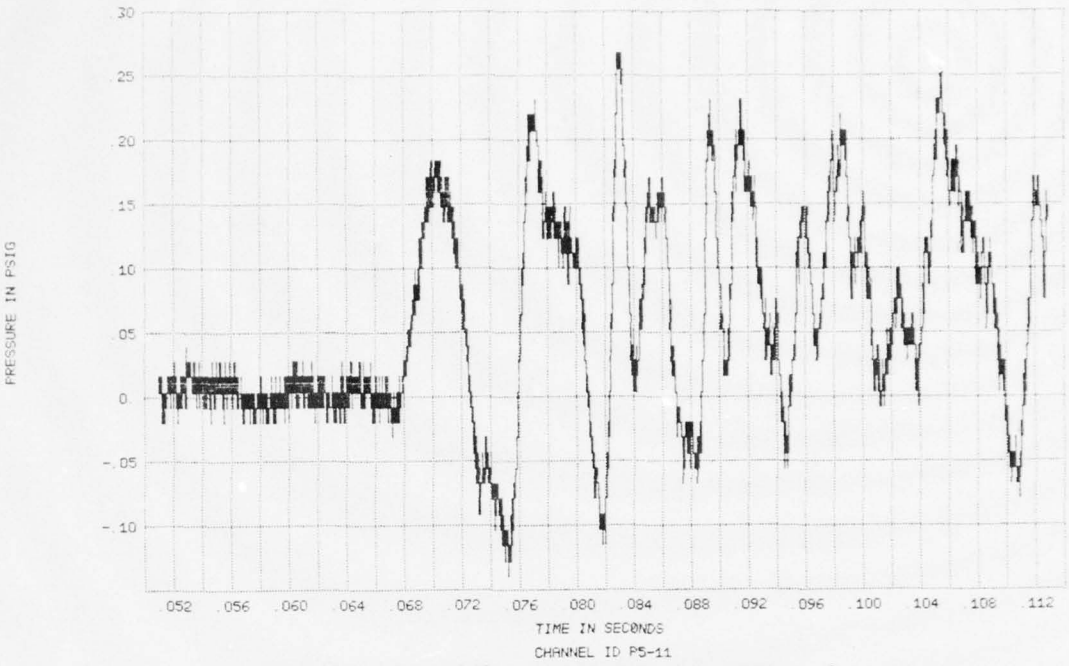


FIGURE 5-106 , SPECIMEN NO. 5 , SHOT NO. 9 ,
INTERNAL PRESSURE TIME HISTORY

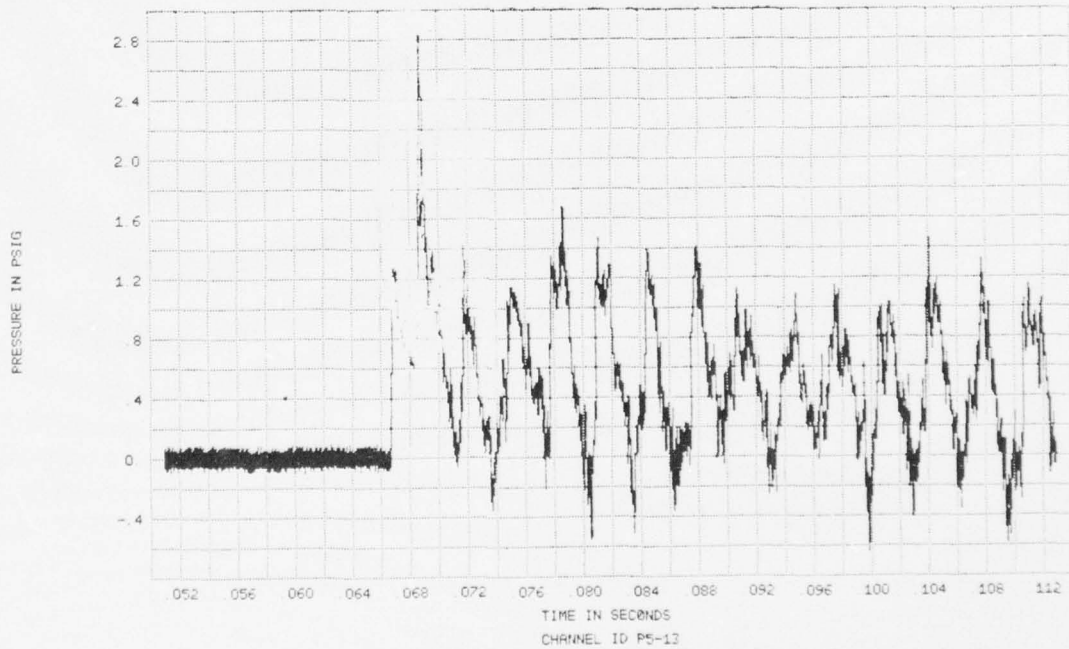


FIGURE 5-107 , SPECIMEN NO. 5 , SHOT NO. 9 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

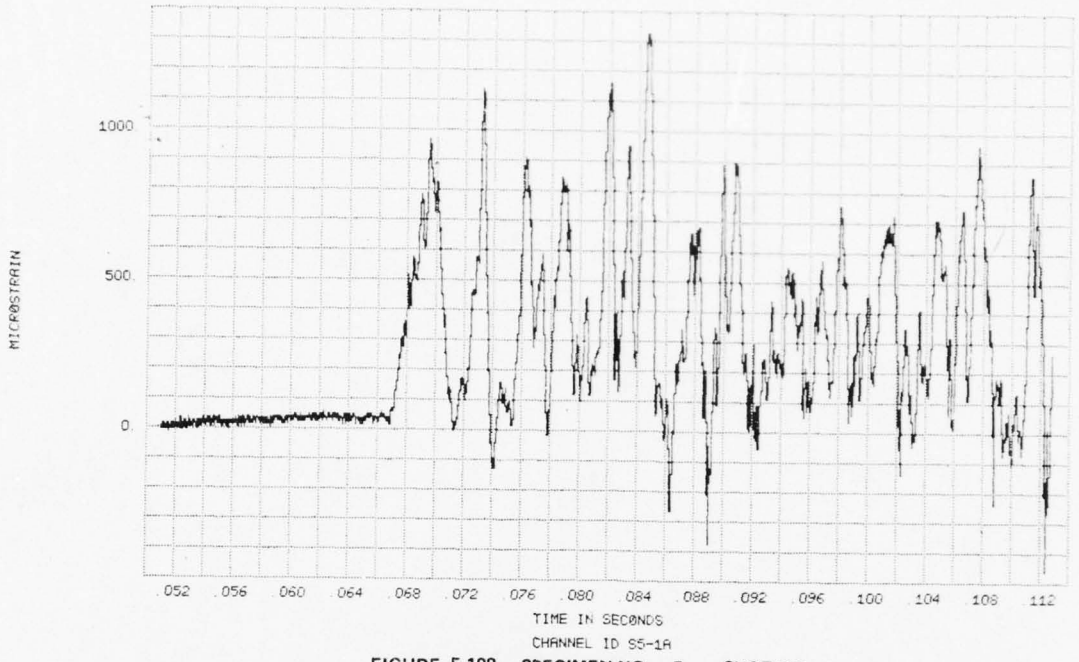


FIGURE 5-108 , SPECIMEN NO. 5 , SHOT NO. 9 , STRAIN TIME HISTORY

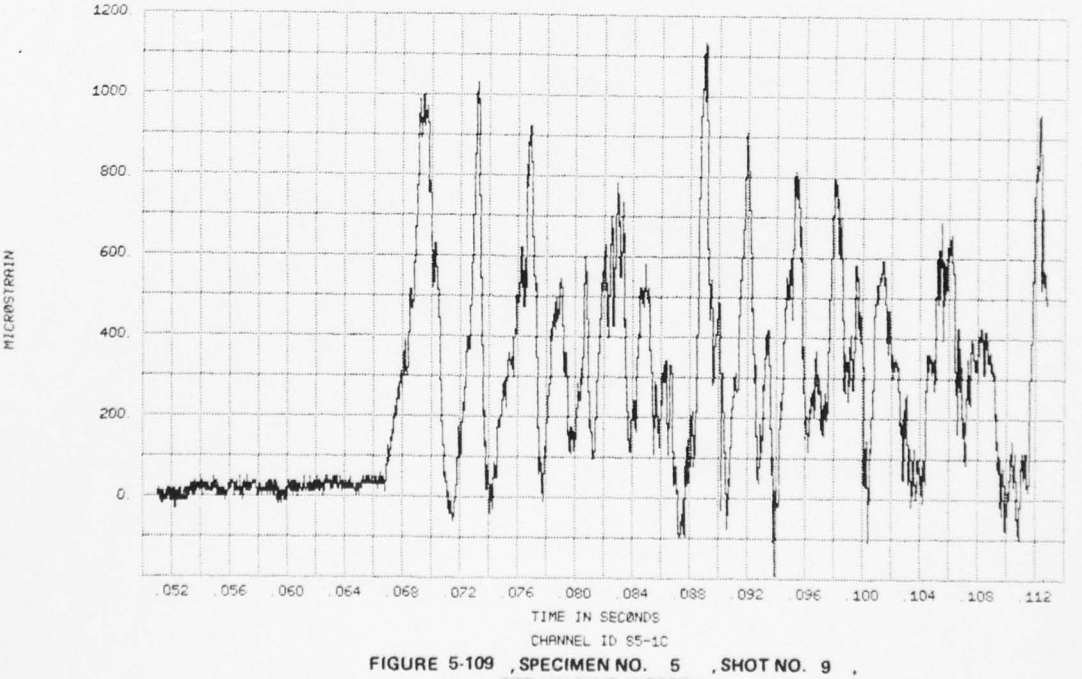


FIGURE 5-109 , SPECIMEN NO. 5 , SHOT NO. 9 , STRAIN TIME HISTORY

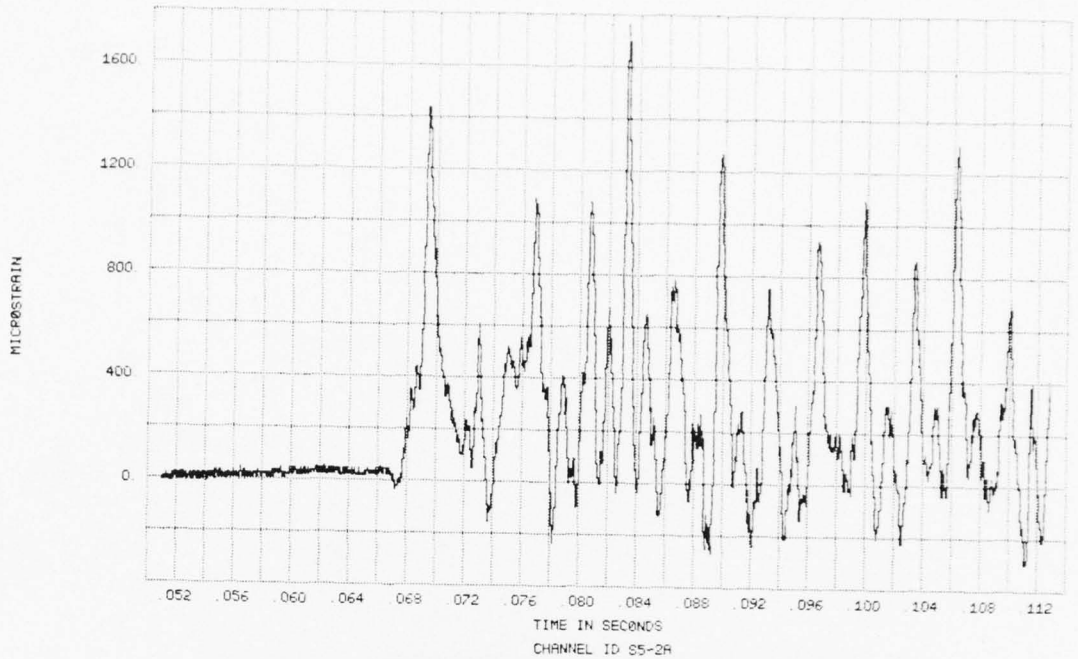


FIGURE 5-110 , SPECIMEN NO. 5 , SHOT NO. 9 ,
STRAIN TIME HISTORY

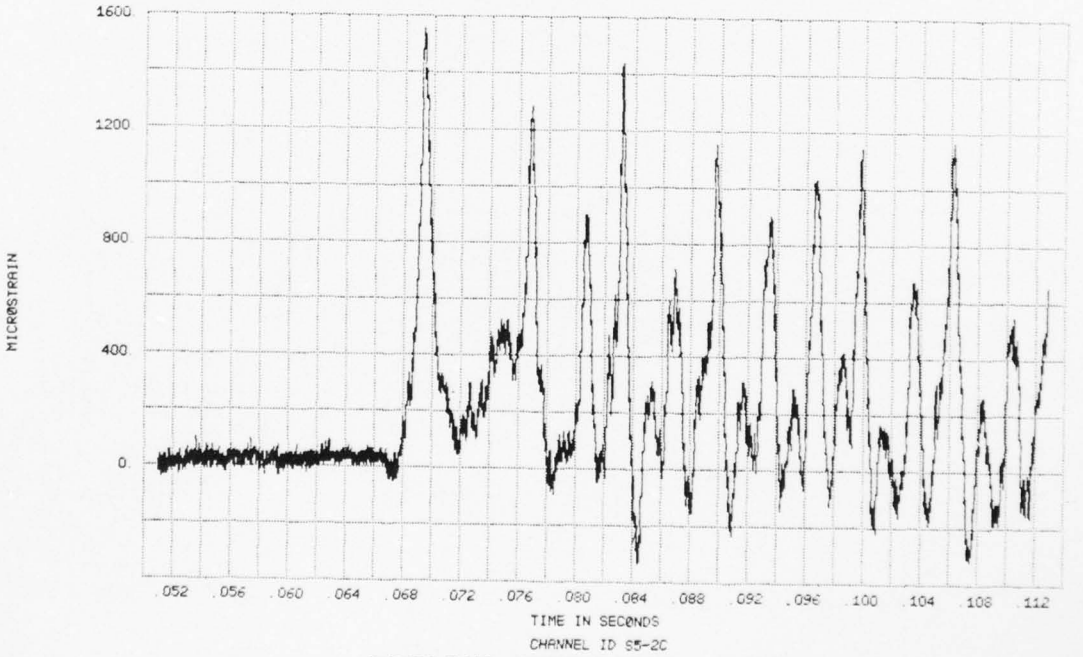


FIGURE 5-111 , SPECIMEN NO. 5 , SHOT NO. 9 ,
STRAIN TIME HISTORY

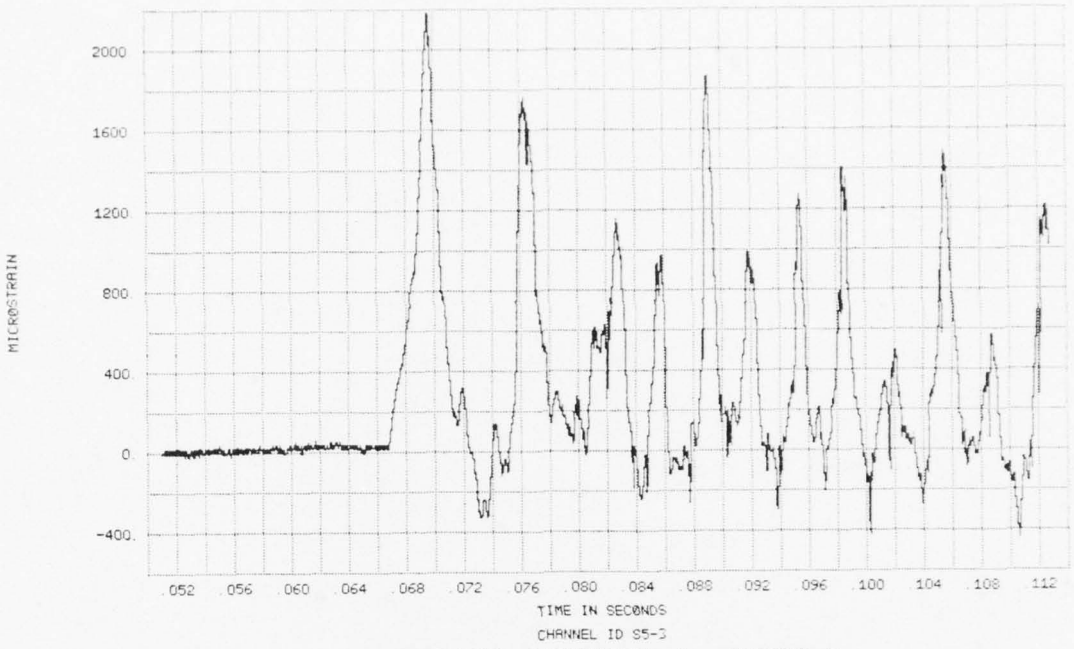


FIGURE 5-112 , SPECIMEN NO. 5 , SHOT NO. 9 ,
STRAIN TIME HISTORY

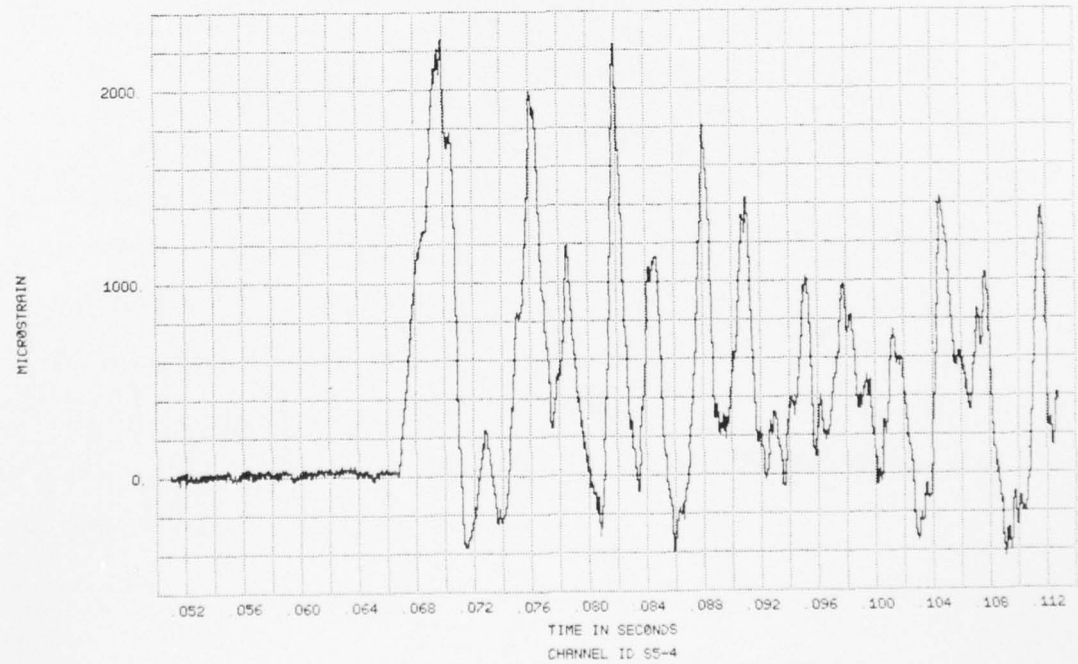


FIGURE 5-113 , SPECIMEN NO. 5 , SHOT NO. 9 ,
STRAIN TIME HISTORY

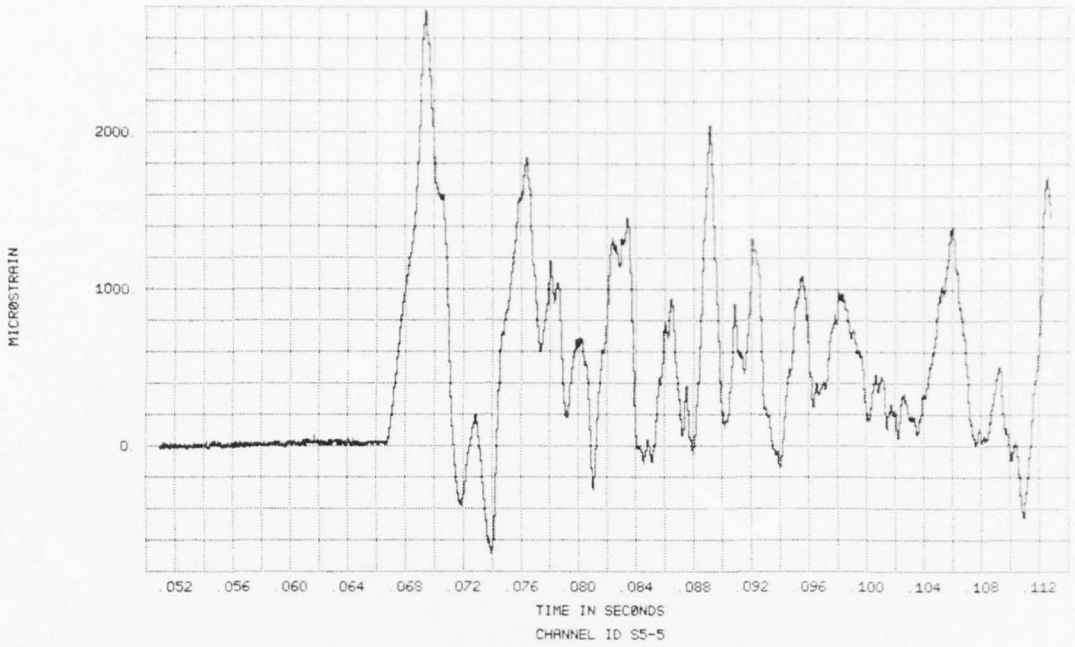


FIGURE 5-114 , SPECIMEN NO. 5 , SHOT NO. 9 ,
STRAIN TIME HISTORY

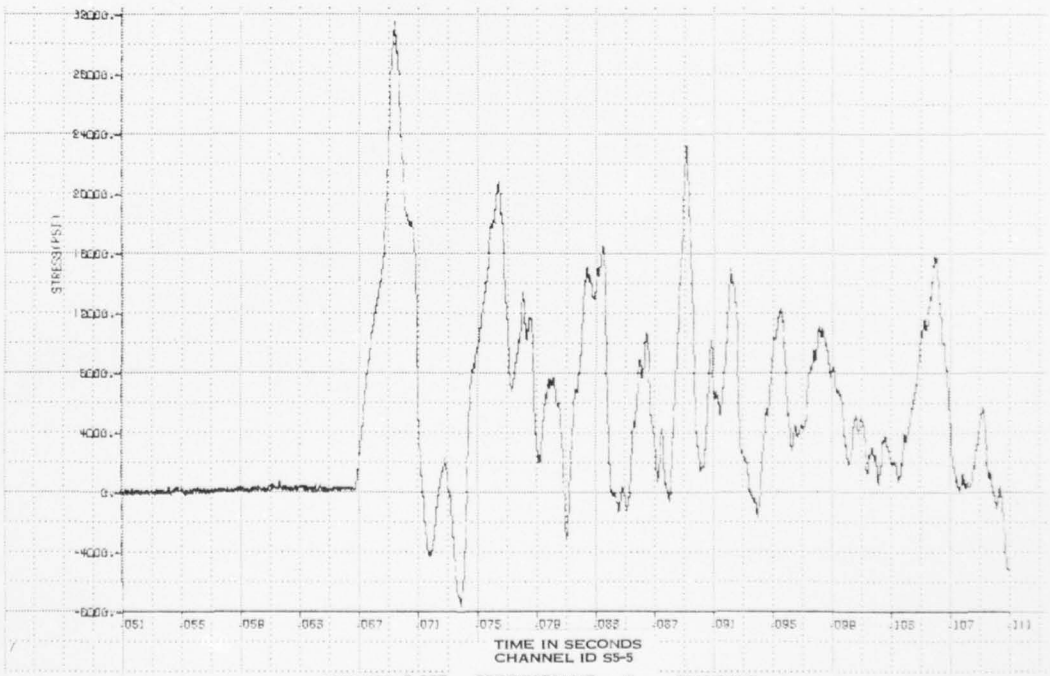


FIGURE 5-115 , SPECIMEN NO. 5 , SHOT NO. 9 ,
STRESS TIME HISTORY

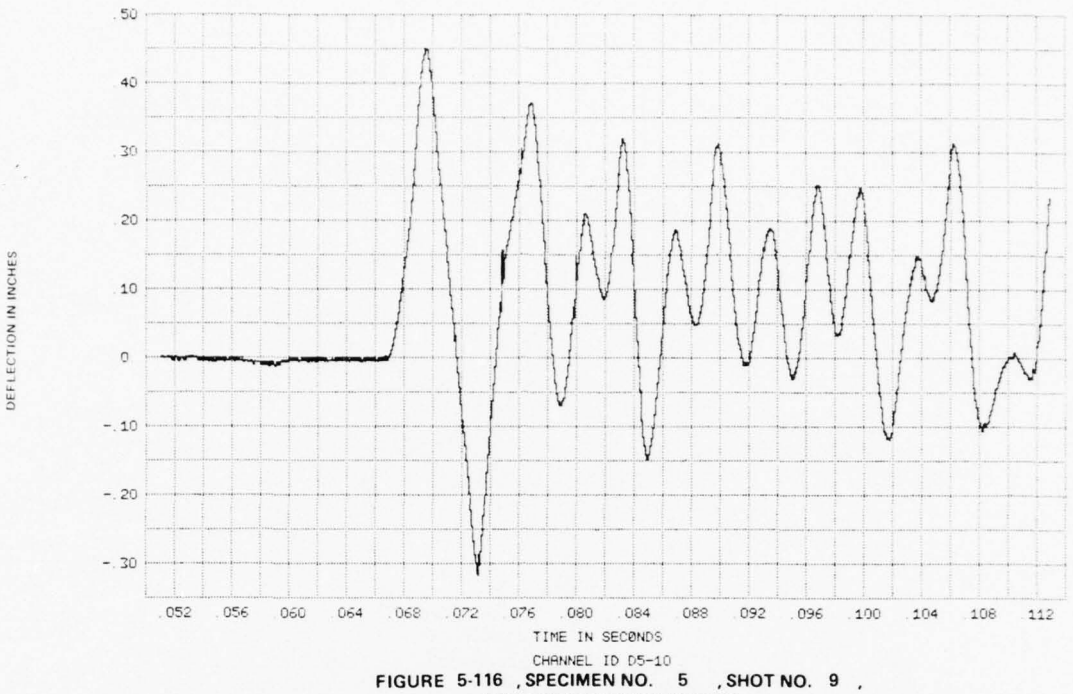


FIGURE 5-116 , SPECIMEN NO. 5 , SHOT NO. 9 ,
DEFLECTION TIME HISTORY

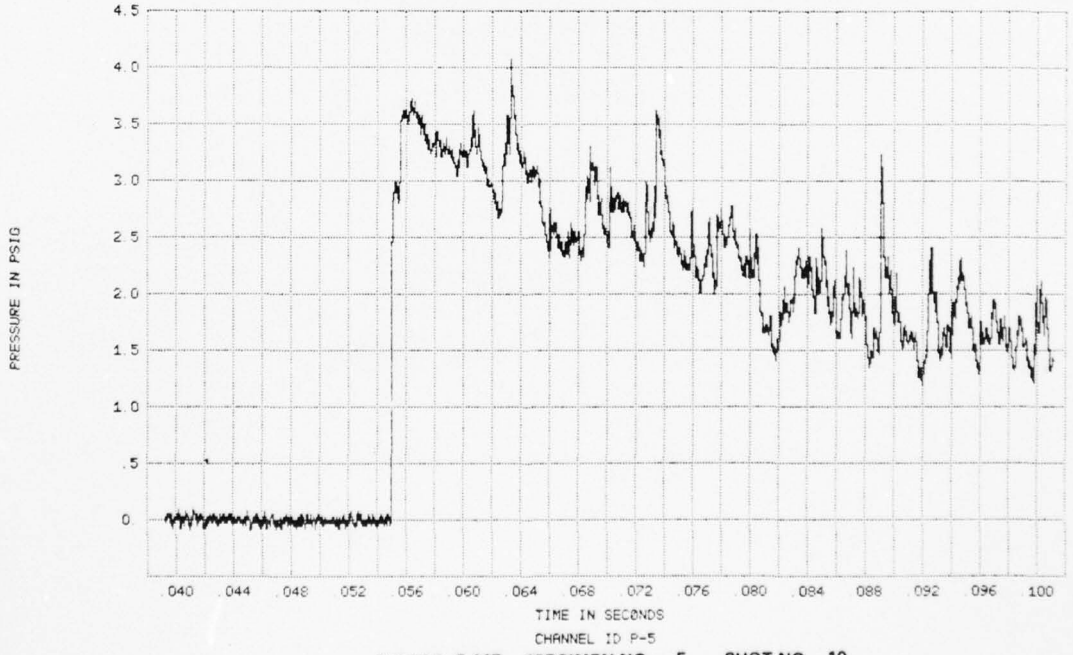


FIGURE 5-117 , SPECIMEN NO. 5 , SHOT NO. 10 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

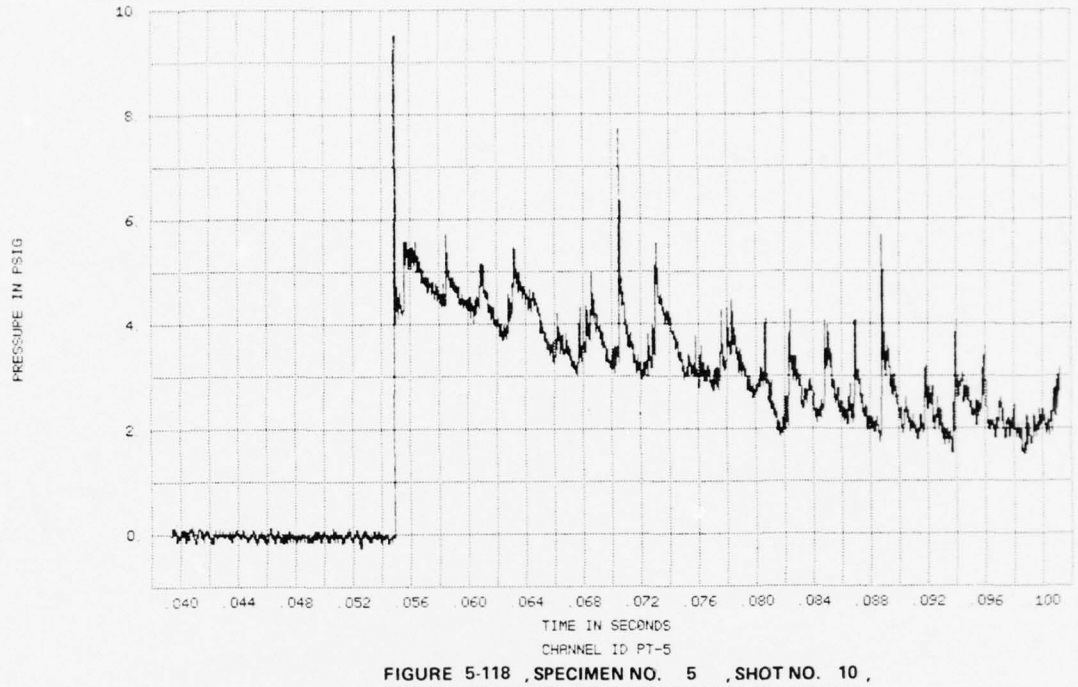


FIGURE 5-118 , SPECIMEN NO. 5 , SHOT NO. 10 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

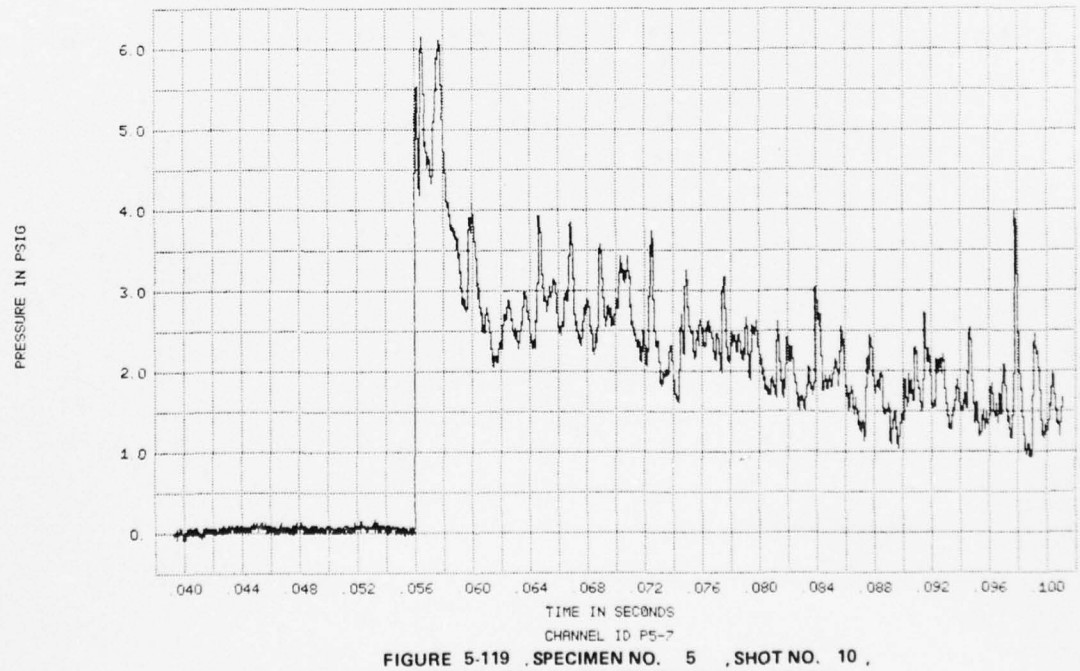


FIGURE 5-119 , SPECIMEN NO. 5 , SHOT NO. 10 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

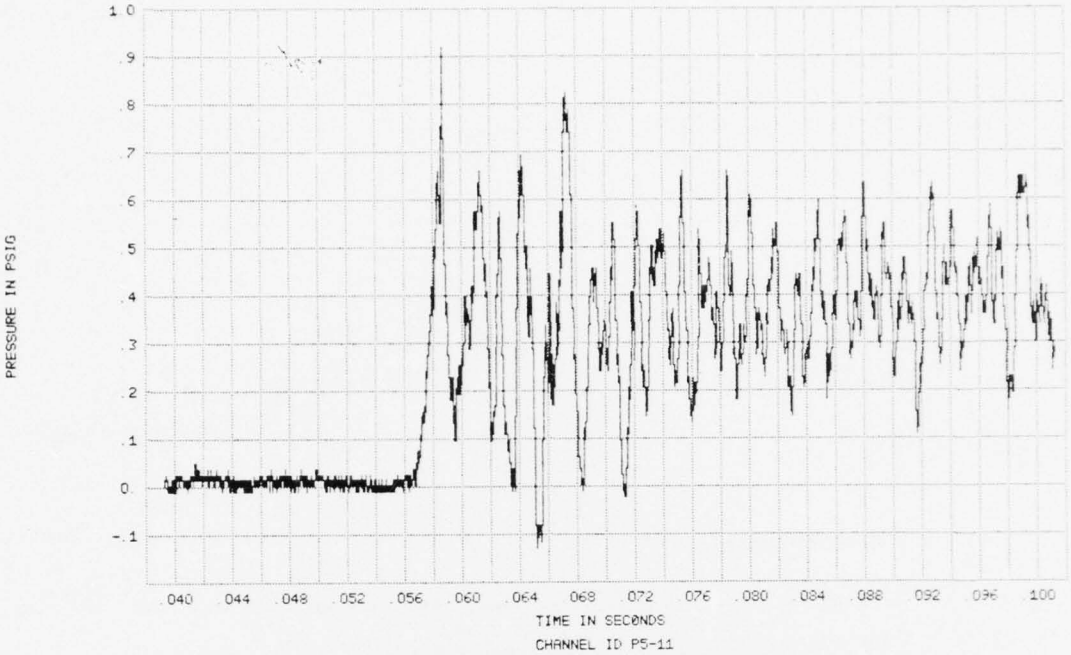


FIGURE 5-120 , SPECIMEN NO. 5 , SHOT NO. 10 ,
INTERNAL PRESSURE TIME HISTORY

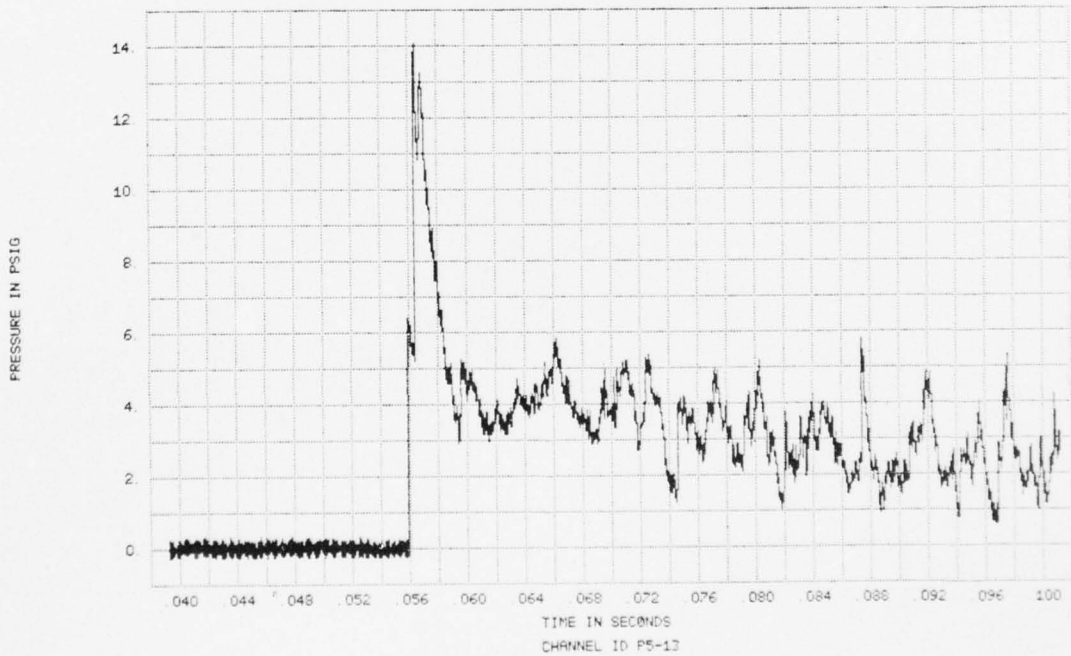


FIGURE 5-121 , SPECIMEN NO. 5 , SHOT NO. 10 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

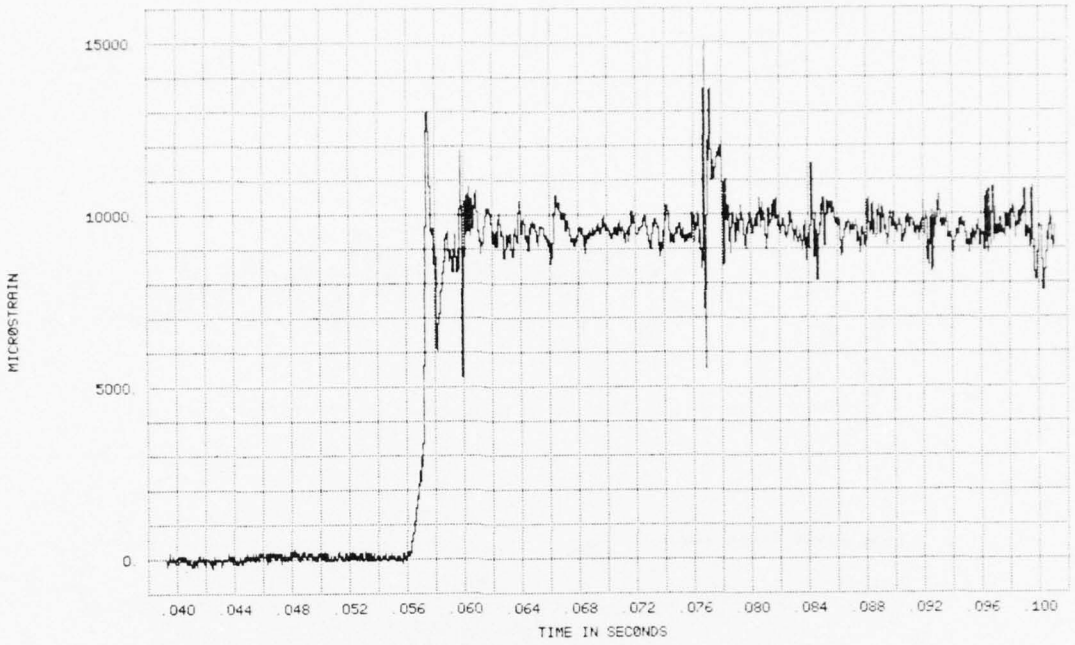


FIGURE 5-122 , SPECIMEN NO. 5 , SHOT NO. 10 ,
STRAIN TIME HISTORY

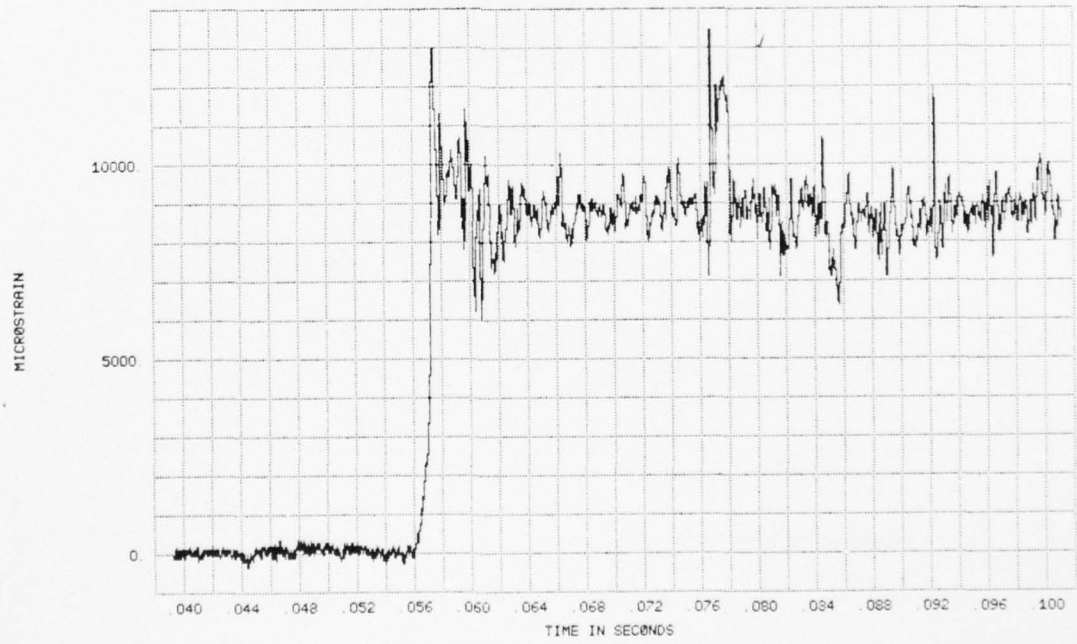


FIGURE 5-123 , SPECIMEN NO. 5 , SHOT NO. 10 ,
STRAIN TIME HISTORY

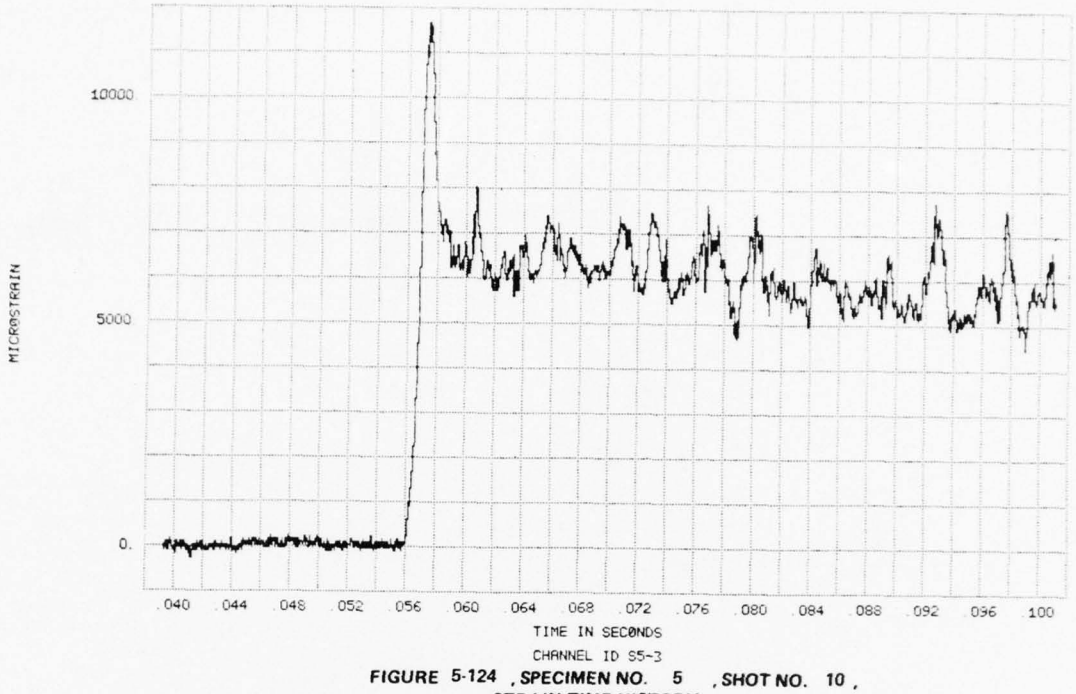


FIGURE 5-124 , SPECIMEN NO. 5 , SHOT NO. 10 , STRAIN TIME HISTORY

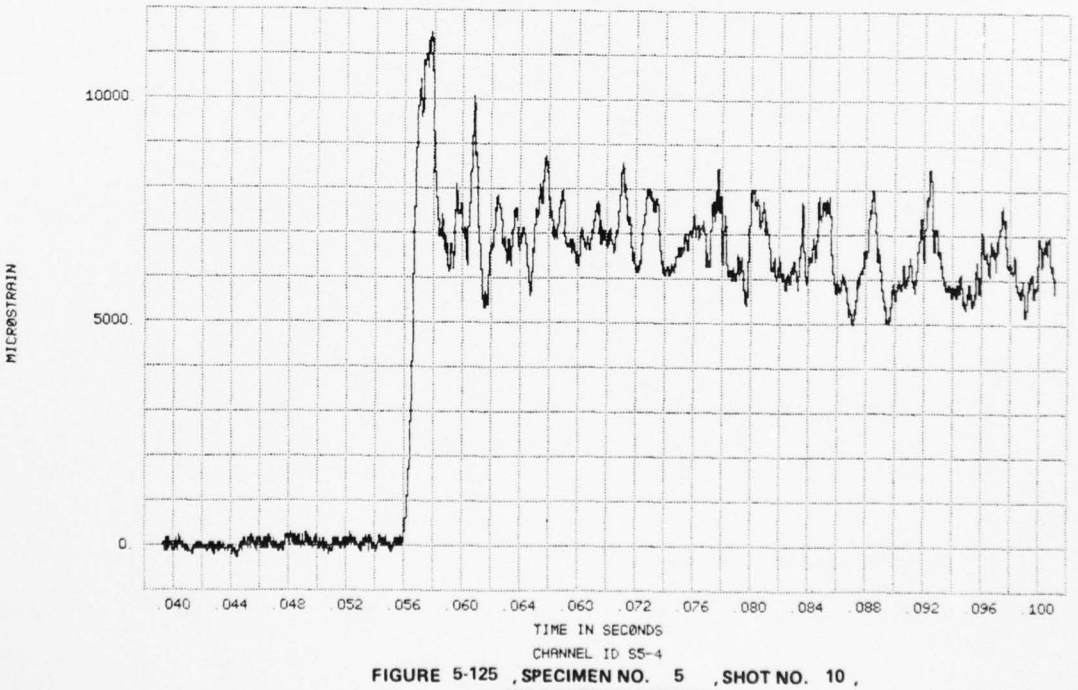


FIGURE 5-125 , SPECIMEN NO. 5 , SHOT NO. 10 , STRAIN TIME HISTORY

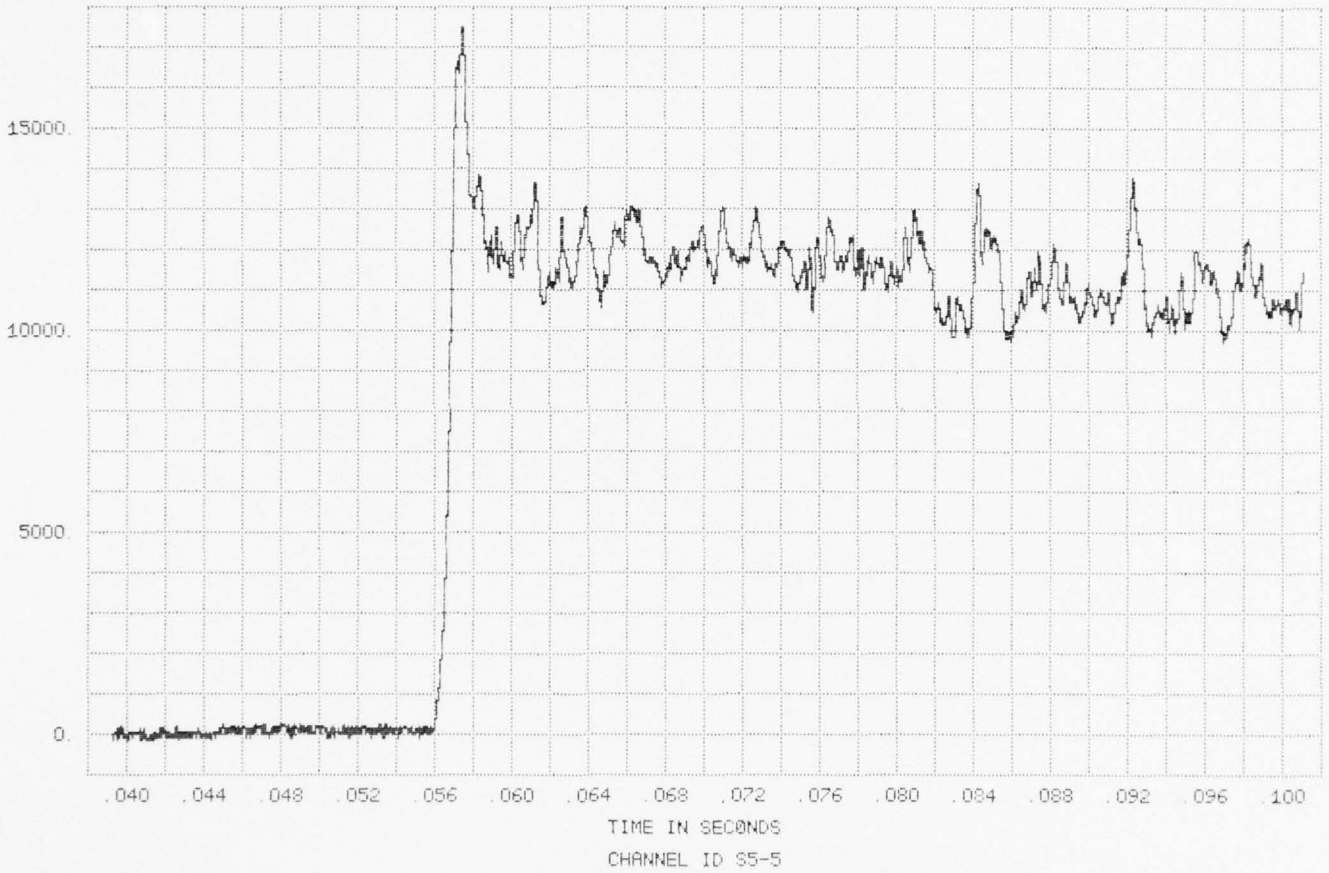
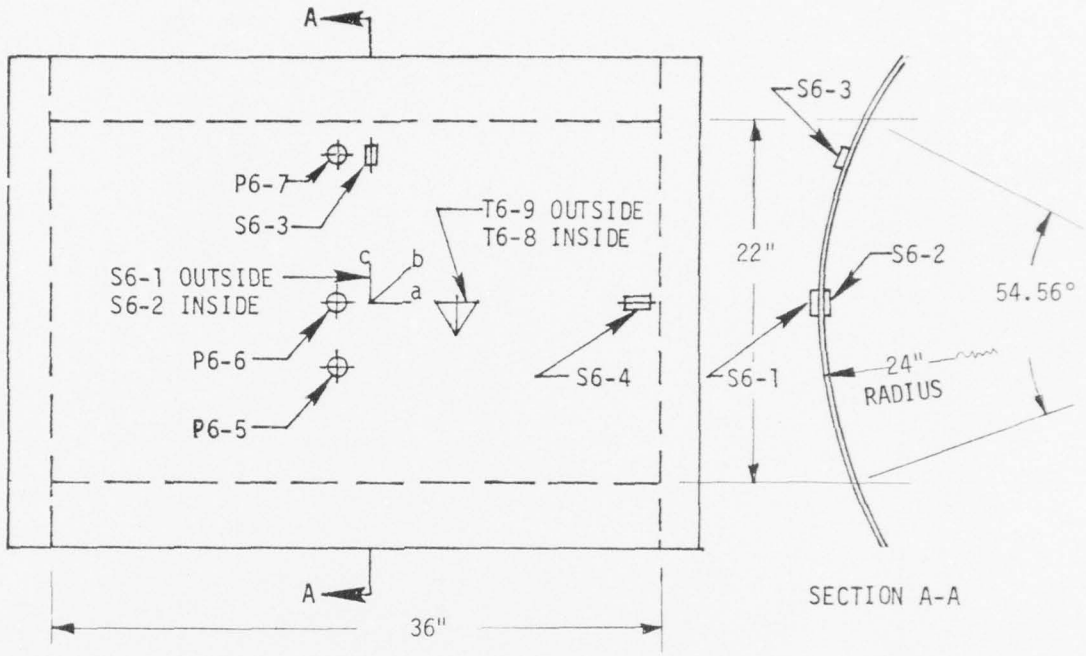


FIGURE 5-126 , SPECIMEN NO. 5 , SHOT NO. 10 , STRAIN TIME HISTORY



SPECIMEN NO. 6

CURVED UNSTIFFENED PANEL

FOUR SIDES CLAMPED

MATERIAL - 6061-T6 ALUMINUM ALLOY

DENSITY - .0002539 lb-sec^2/in^4 (MIL-HDBK-5)

POISSON'S RATIO - .33

MODULUS OF ELASTICITY - 10.9 x 10^6 PSI

SHEAR MODULUS - 3.8 x 10^6 PSI

% ELONGATION - 15.0

F_{ty} - 40,500 PSI

F_{tu} - 45,200 PSI

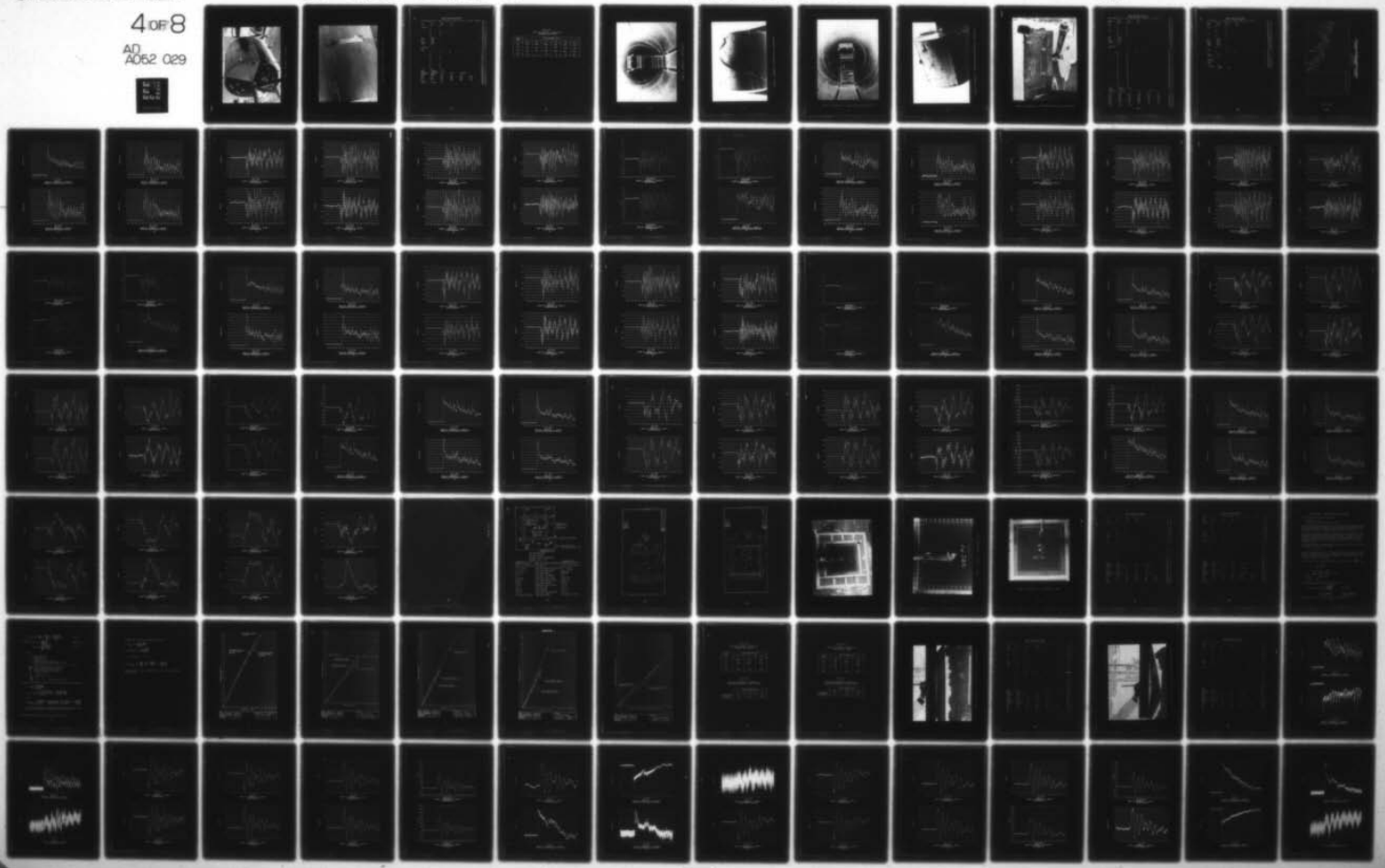
THICKNESS - .080 IN.

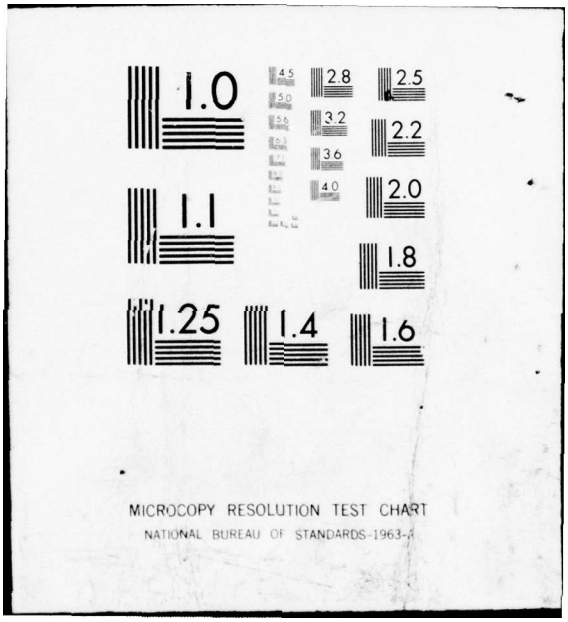
This test specimen was modeled as a unit width curved beam as well as curved panel. The beam was considered to be clamped at both ends.



AD-A052 029 BOEING WICHITA CO KS F/G 18/3
STRUCTURAL RESPONSE TO SIMULATED NUCLEAR OVERPRESSURE (STRESNO)--ETC(U)
MAR 77 R P SYRING, W D PIERSON DNA001-76-C-0084
UNCLASSIFIED D3-9788-5-VOL-2 DNA-4278F-2 NL

4 OF 8
AD A052 029




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

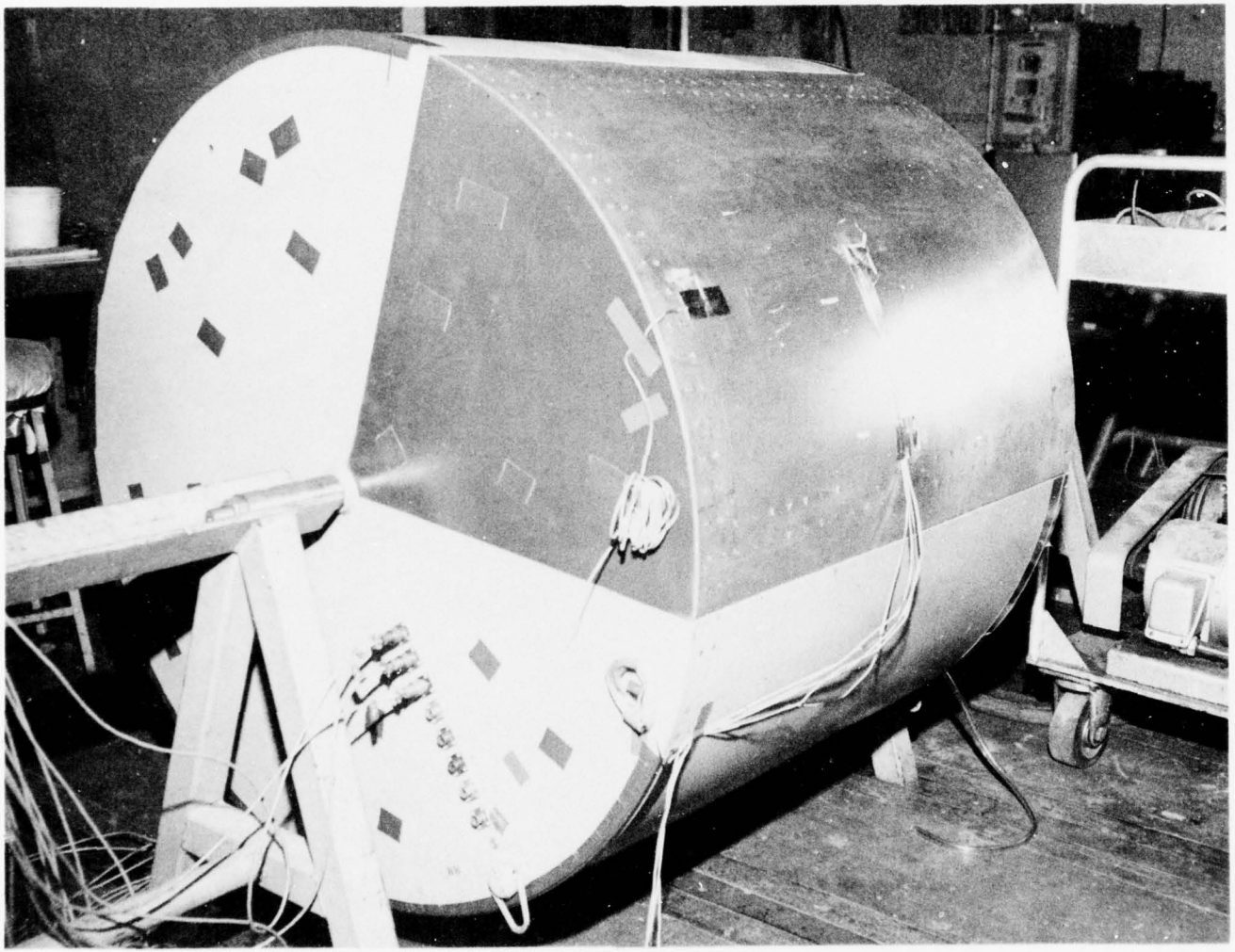


FIGURE 6-1 - SPECIMEN NO. 6 - TEST SET-UP

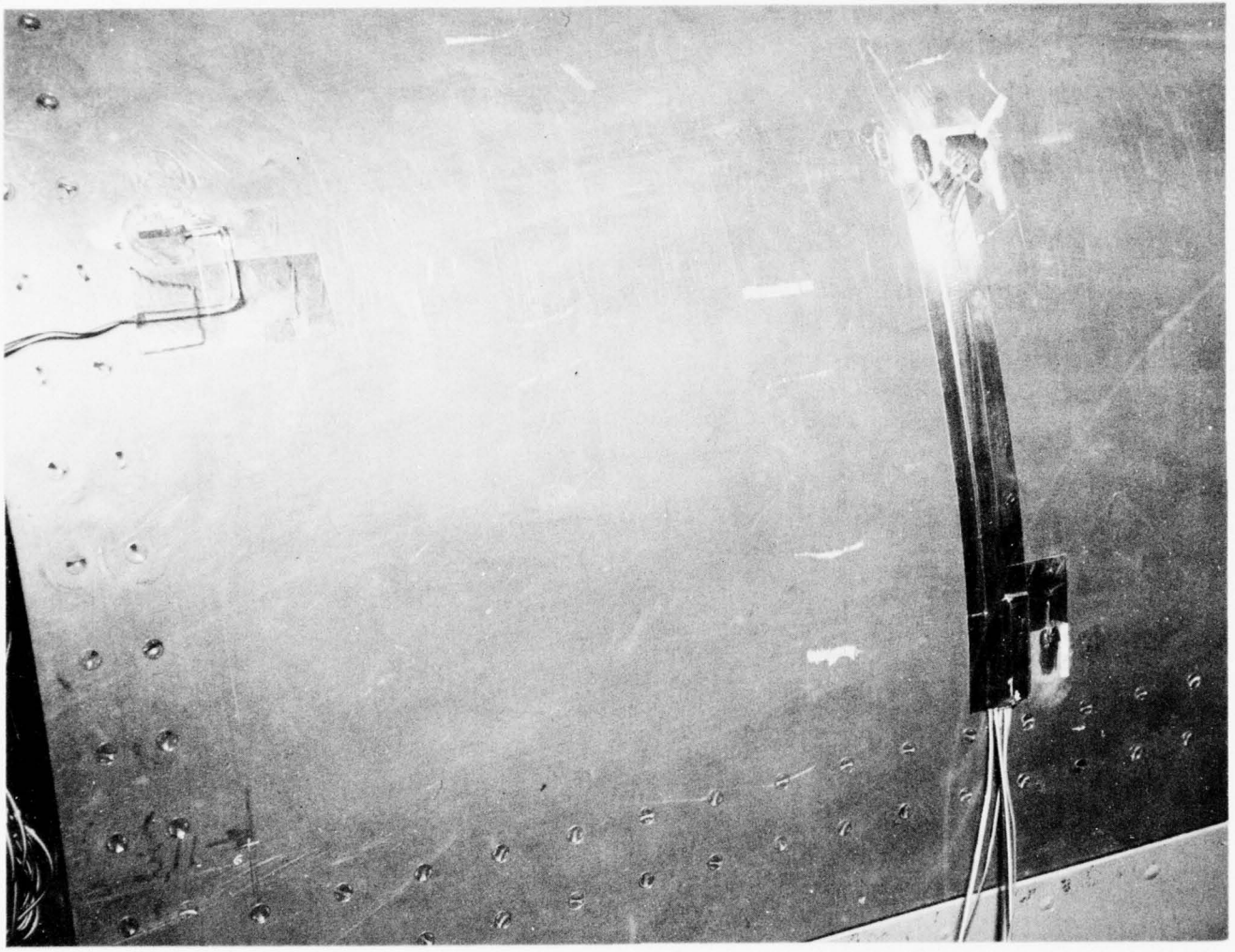


FIGURE 6-2 - SPECIMEN NO. 6 - INSTRUMENTATION - OUTSIDE

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.6 - STATIC ANALYSIS - PRESS = 5.0 PSI - MAY'76 - SYRING   GP   1
          1           0                                                    GP   2
0.0        0.1         0.01        0.0                                     GP   3
0.0        0.0         0.0         0.0                                     GP   4
         15          15                                                    GP   5
100000.                                                                    GP   7
                                                                           GP   8
          2           0                                                    GP   9
          2                                                                GP  10
          0           0                                                    GP  12
          0           0                                                    GP  15
          0           0                                                    GP  16
          3                                                                GP  21
0.0       -36.0                                                            GP  22
0.0        0.0                                                             GP  23
0.0       24.0                                                             GP  24
-18.0     24.0                                                             GP  24
-36.0     24.0                                                             GP  24
          2           1                                                    GP  25
          2                                                                GP  27
1.570796                                                                   GP  28
0.0                                                                        GP  29
-5.0                                                                       GP  30
          5           5          11          11                          GPP   1
          1           1           1                                      GPP   2
         10                                                              GPP   3
          2           5                                                  GPP   4
          3           4                                                  GPP   4
          3           5                                                  GPP   4
          4           3                                                  GPP   4
          4           4                                                  GPP   4
          4           5                                                  GPP   4
          5           2                                                  GPP   4
          5           3                                                  GPP   4
          5           4                                                  GPP   4
          5           5                                                  GPP   4
          1                                                              GPP   5
36.0      54.56       24.0                                               GPP   6
0.08      0.0002539                                                      GPP   7
10900000. 10900000.   0.33        0.33        3800000.                   GPP   8
40500.    40500.                                                       GPP   9
0.0       0.0         0.0         0.0         0.0         0.0            GPP  13
0.0       0.0         0.0         0.0         0.0         0.0            GPP  13
0.0       0.0         0.0         0.0         0.0         0.0            GPP  13
0.0       0.0         0.0         0.0         0.0         0.0            GPP  13
0.0                                                                        GPP  13
.000001   .000001     1.0                                                GPP  14
                                                                           GP  32
```

TABLE XXXI

STATIC TEST STRESSES - SPECIMEN NO. 6
(STRESSES GIVEN IN PSI)

STRAIN GAUGE	STATIC PRESSURE (PSI)					
	1.2	2.4	3.6	4.2	4.8	5.1
S6-1	-552.	-1044.	-2004.	-2556.	-3389.	-4036.
S6-2	-253.	-412.	-377.	-279.	-148.	650.
S6-3	-379.	-783.	-1285.	-1603.	-2092.	-2557.
S6-4	-12.	0	49.	73.	172.	245.

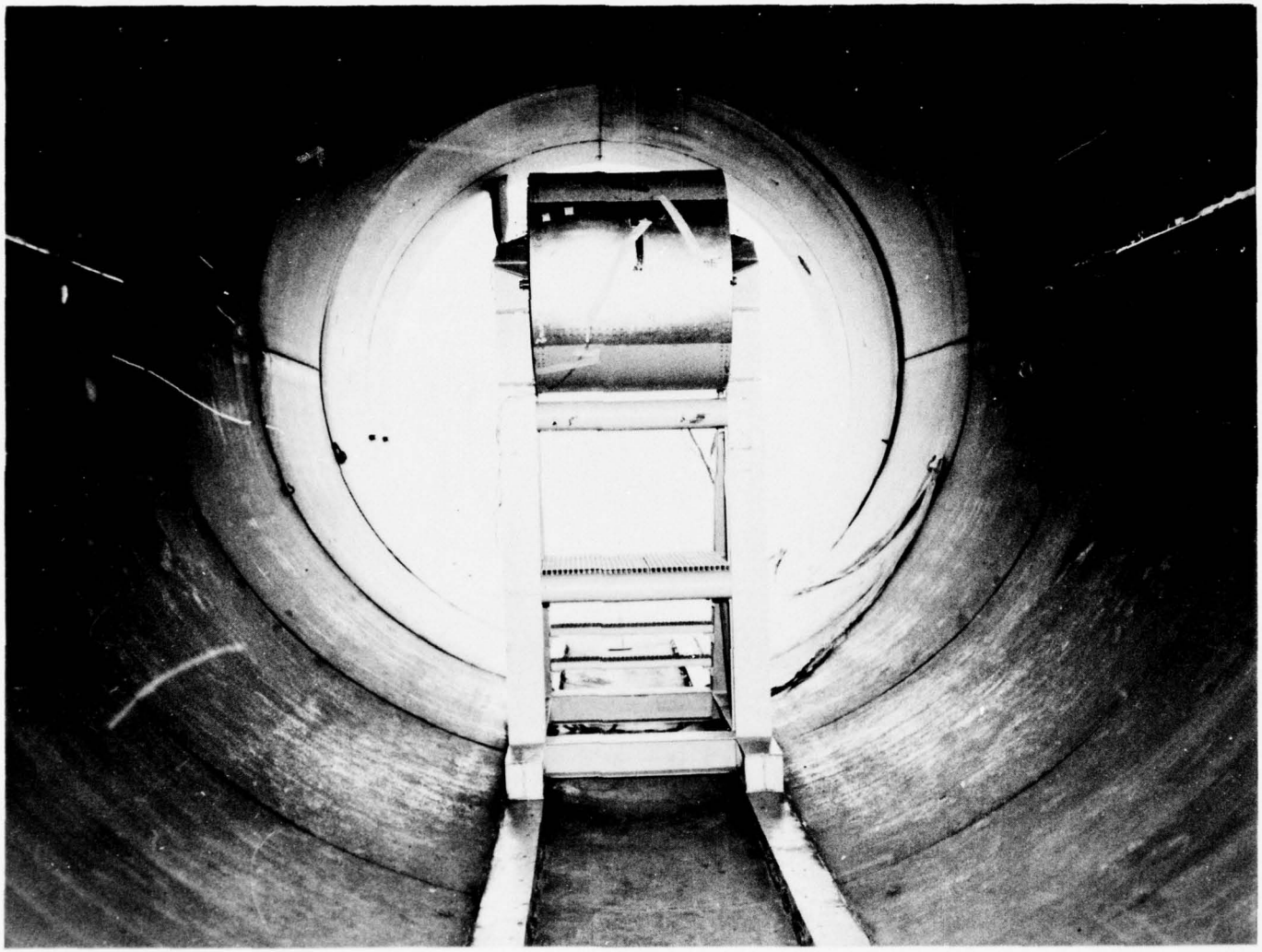


FIGURE 6-3 - SPECIMEN NO. 6 - SHOCK TEST SET-UP

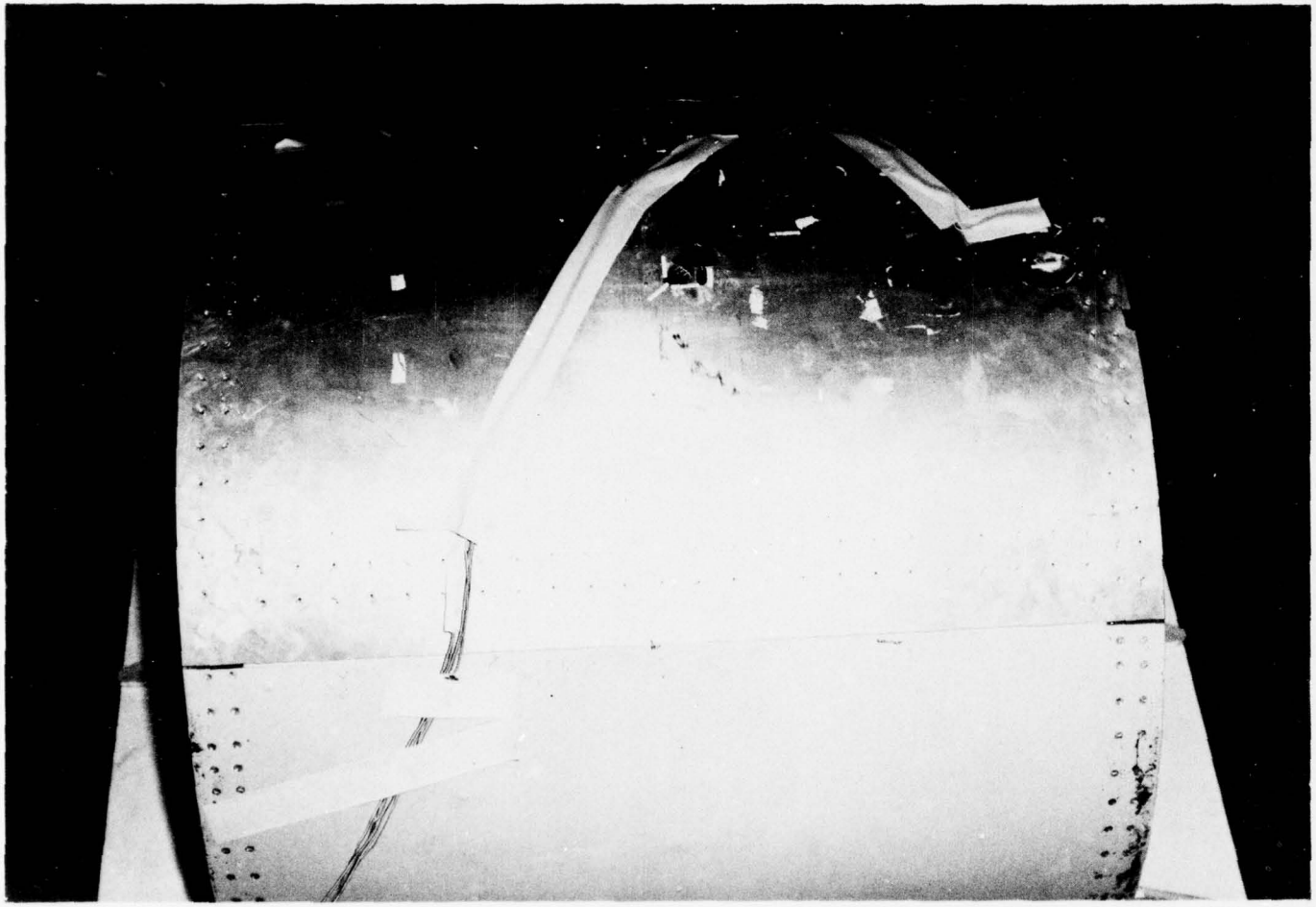


FIGURE 6-4 - SPECIMEN NO. 6 - SHOCK TEST SET-UP - CLOSE-UP VIEW

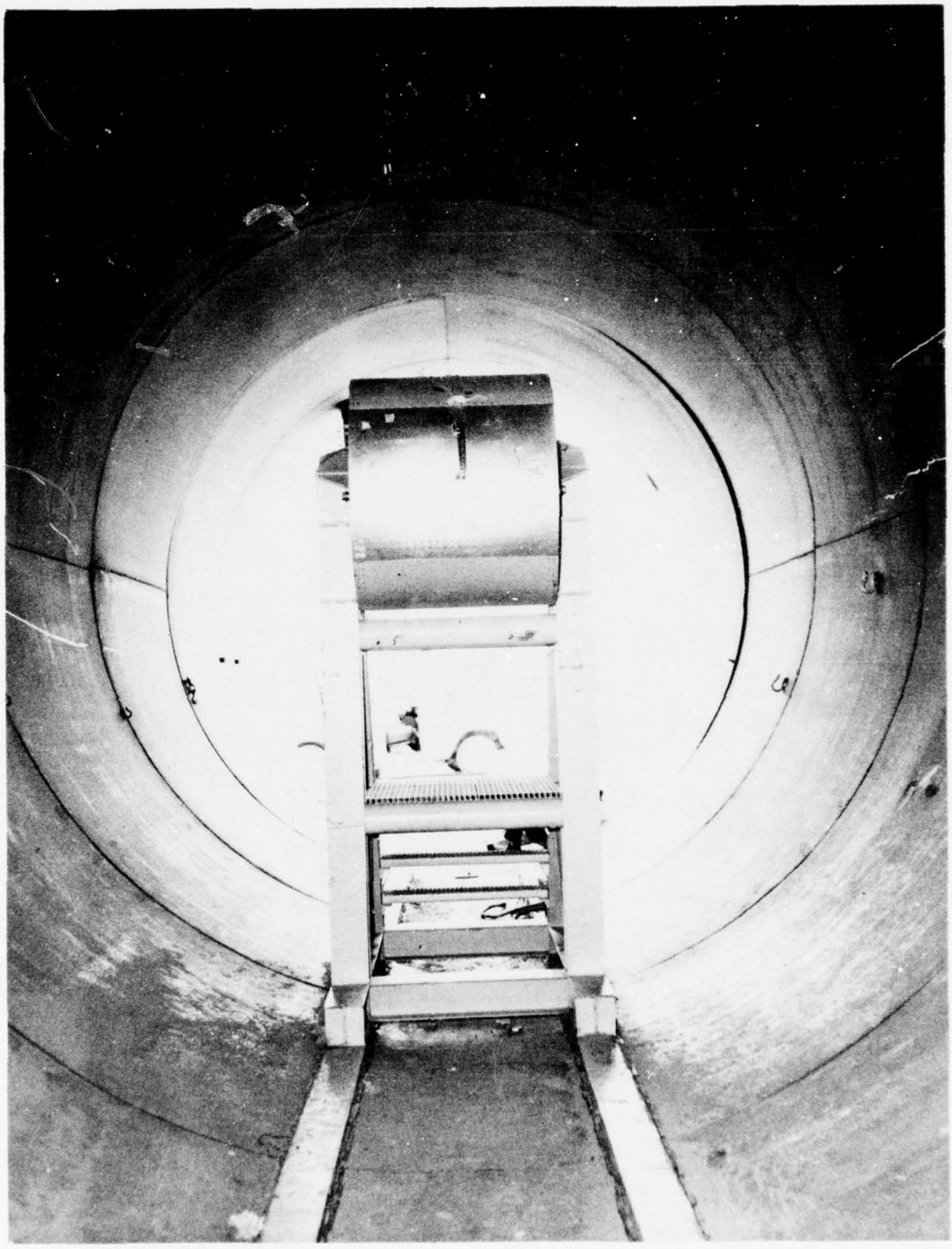


FIGURE 6-5 - SPECIMEN NO. 6 - SPECIMEN IN FIXTURE AFTER SHOCK TEST

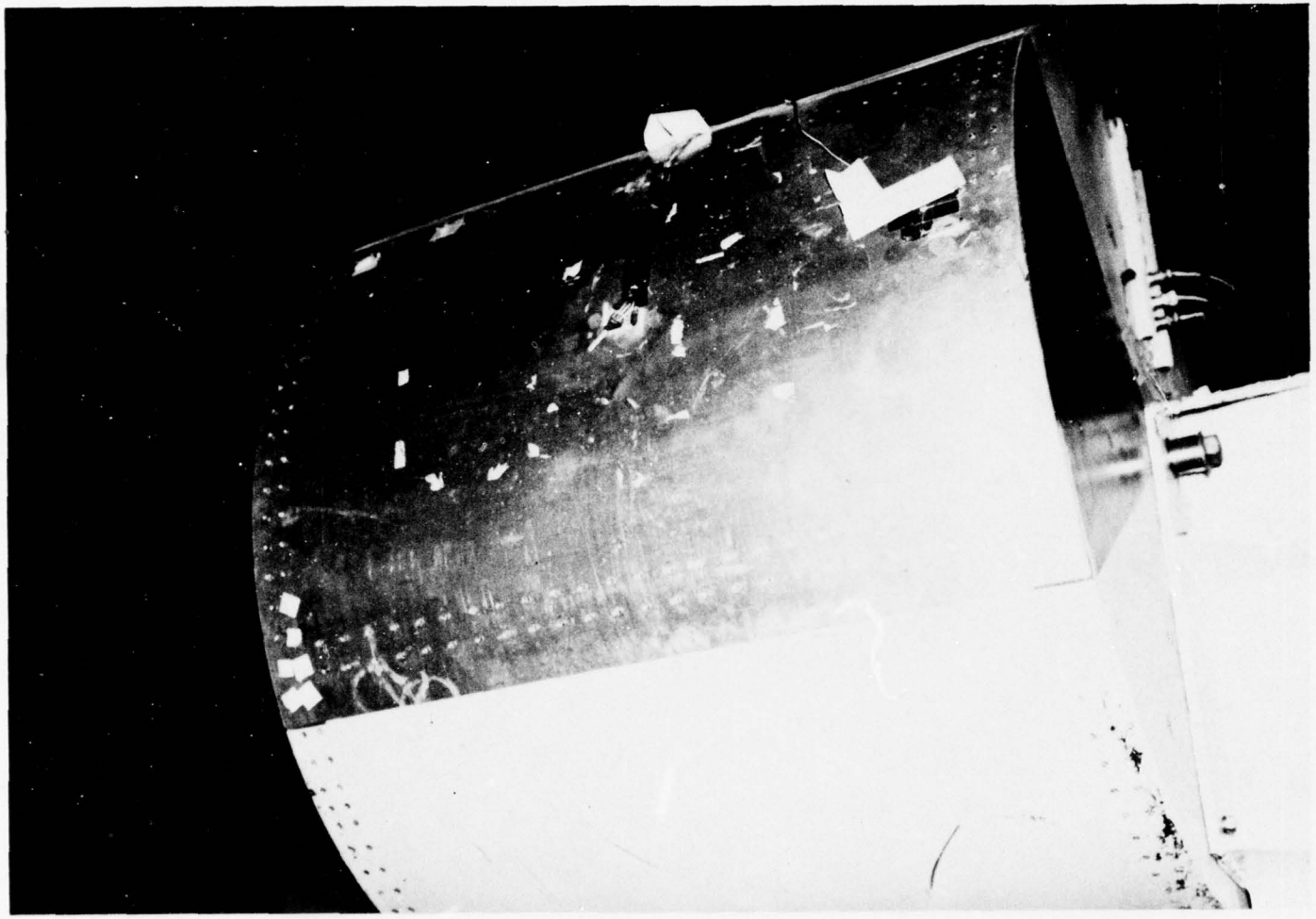


FIGURE 6-6 - SPECIMEN NO. 6 - SPECIMEN IN FIXTURE AFTER SHOCK TEST - CLOSE-UP VIEW

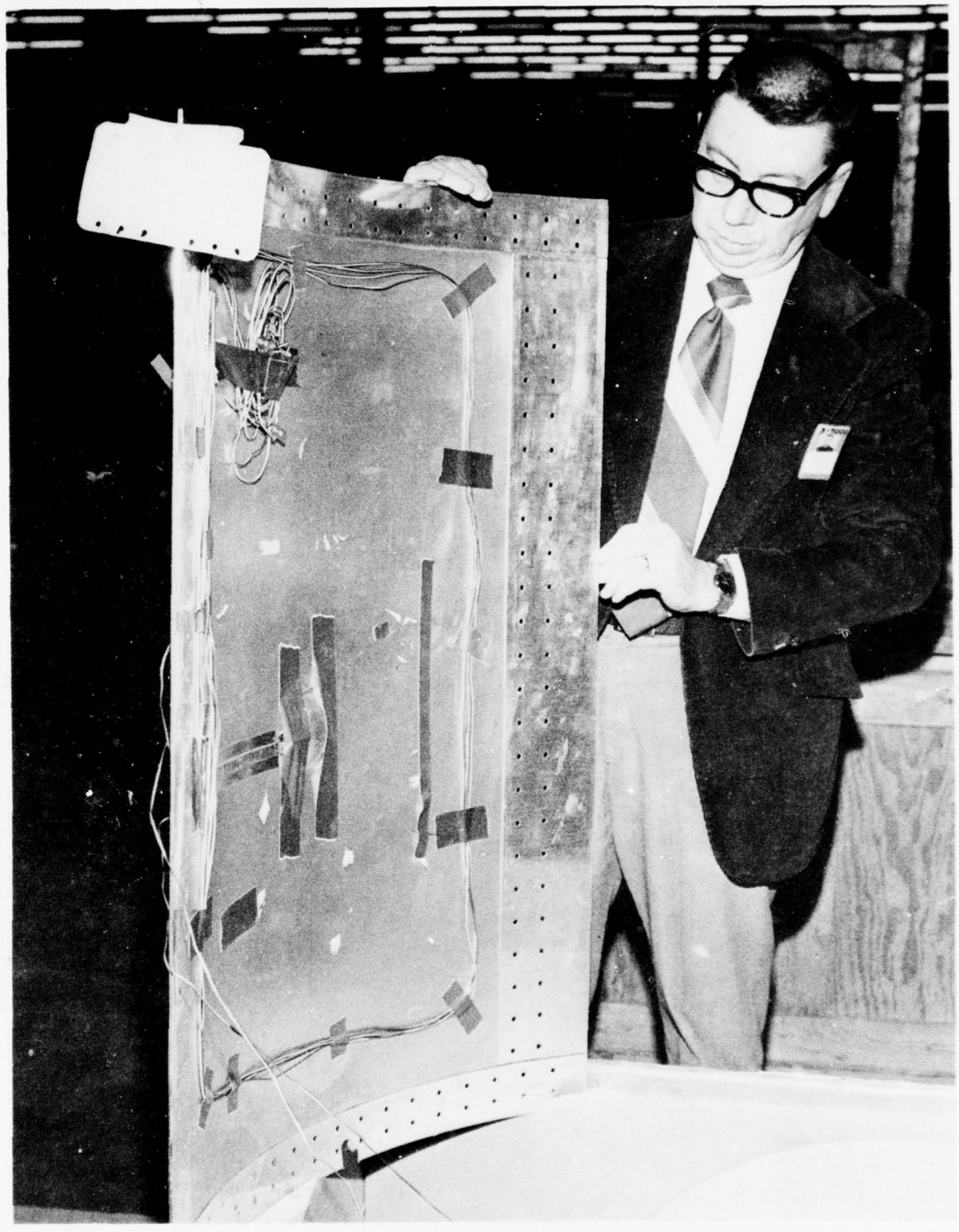


FIGURE 6-7 - SPECIMEN NO. 6 - SPECIMEN AFTER SHOCK TEST - NO VISIBLE DAMAGE

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO. 6  - DYNAMIC ANALYSIS - ITERATIVE FPU SOLUTION                GP  1
          1          0                                                          GP  2
5000.      0.001      0.02       0.0                                           GP  3
0.0        0.0        0.0        0.0                                           GP  4
         15         15                                                         GP  5
500.                                                                           GP  7
                                                                               GP  8
          2          0                                                         GP  9
          0          1                                                         GP 10
0.5                                                                            GP 11
          0          0                                                         GP 12
          0          0                                                         GP 15
          0          0                                                         GP 18
          3                                                                    GP 21
0.0       -36.0                                                                GP 22
0.0        0.0                                                                 GP 23
0.0        24.0                                                                GP 24
-18.0      24.0                                                                GP 24
-36.0      24.0                                                                GP 24
          2          1                                                         GP 25
          2                                                                    GP 27
1.570796                                                                       GP 28
0.0                                                                            GP 29
                                                                               GP 30
          1          7         15         15                                  GPP  1
          1          1          1                                             GPP  2
         24                                                                    GPP  3
          3          4                                                         GPP  4
          3          5                                                         GPP  4
          3          6                                                         GPP  4
          3          7                                                         GPP  4
          4          3                                                         GPP  4
          4          4                                                         GPP  4
          4          5                                                         GPP  4
          4          6                                                         GPP  4
          4          7                                                         GPP  4
          5          3                                                         GPP  4
          5          4                                                         GPP  4
          5          5                                                         GPP  4
          5          6                                                         GPP  4
          5          7                                                         GPP  4
          6          3                                                         GPP  4
          6          4                                                         GPP  4
          6          5                                                         GPP  4
          6          6                                                         GPP  4
          6          7                                                         GPP  4
          7          3                                                         GPP  4
          7          4                                                         GPP  4
          7          5                                                         GPP  4
          7          6                                                         GPP  4
          7          7                                                         GPP  4
          1                                                                    GPP  5
36.0       54.36      24.0                                                     GPP  6
0.08       0.0002539                                                           GPP  7
10900000.  10900000.  0.33       0.33       3800000.                          GPP  8
40500.     40500.                                                            GPP  9
0.0        0.0        0.0        0.0        0.0        0.0                    GPP 13
0.0        0.0        0.0        0.0        0.0        0.0                    GPP 13
0.0        0.0        0.0        0.0        0.0        0.0                    GPP 13
0.0        0.0        0.0        0.0        0.0        0.0                    GPP 13
0.0        0.0        0.0        0.0        0.0        0.0                    GPP 13
0.0        0.0        0.0        0.0        0.0        0.0                    GPP 13
0.0        0.0        0.0        0.0        0.0        0.0                    GPP 13
0.0        0.0        0.0        0.0        0.0        0.0                    GPP 13
0.0                                                                            GPP 13
0.0        0.015      10.0                                                     GPP 14
                                                                               GP  32
```

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO. 6 MODELED AS A BEAM -ITERATIVE TPD SOLUTIO                    GP  1
                1                0                                              GP  2
5000.            0.001            0.02            0.0                           GP  3
0.0              0.0              0.0             0.0                           GP  4
                15               15                                             GP  5
                                                                                GP  7
375.
                                                                                GP  8
                                                                                GP  9
                2                0                                              GP 10
                0                1                                              GP 11
0.5
                                                                                GP 12
                0                0                                              GP 15
                0                0                                              GP 18
                0                0                                              GP 21
                3                                                               GP 22
0.0              -36.0                                                          GP 23
0.0              0.0                                                            GP 24
0.0              24.0                                                           GP 24
-18.0            24.0                                                           GP 24
-36.0            24.0                                                           GP 25
                2                7                                              GP 27
                2                                                               GP 29
0.0
0.0                                                                             GP 30
                1                2                2               1              1              0  GP  1
                20               1                0                                                 GP  2
24.0                                                                            GP  3
1.095            2.047                                                          GP  4
                                                                                GP  8
                0                                                               GP 12
.0002539                                                                        GP 13
1.0                                                                             GP 14
0.08                                                                            GP 15
1.0                                                                             GP 16
                1                                                               GP 17
.003716          40500.                                                         GP 18
                 0.020           25.0                                           GP 22
```

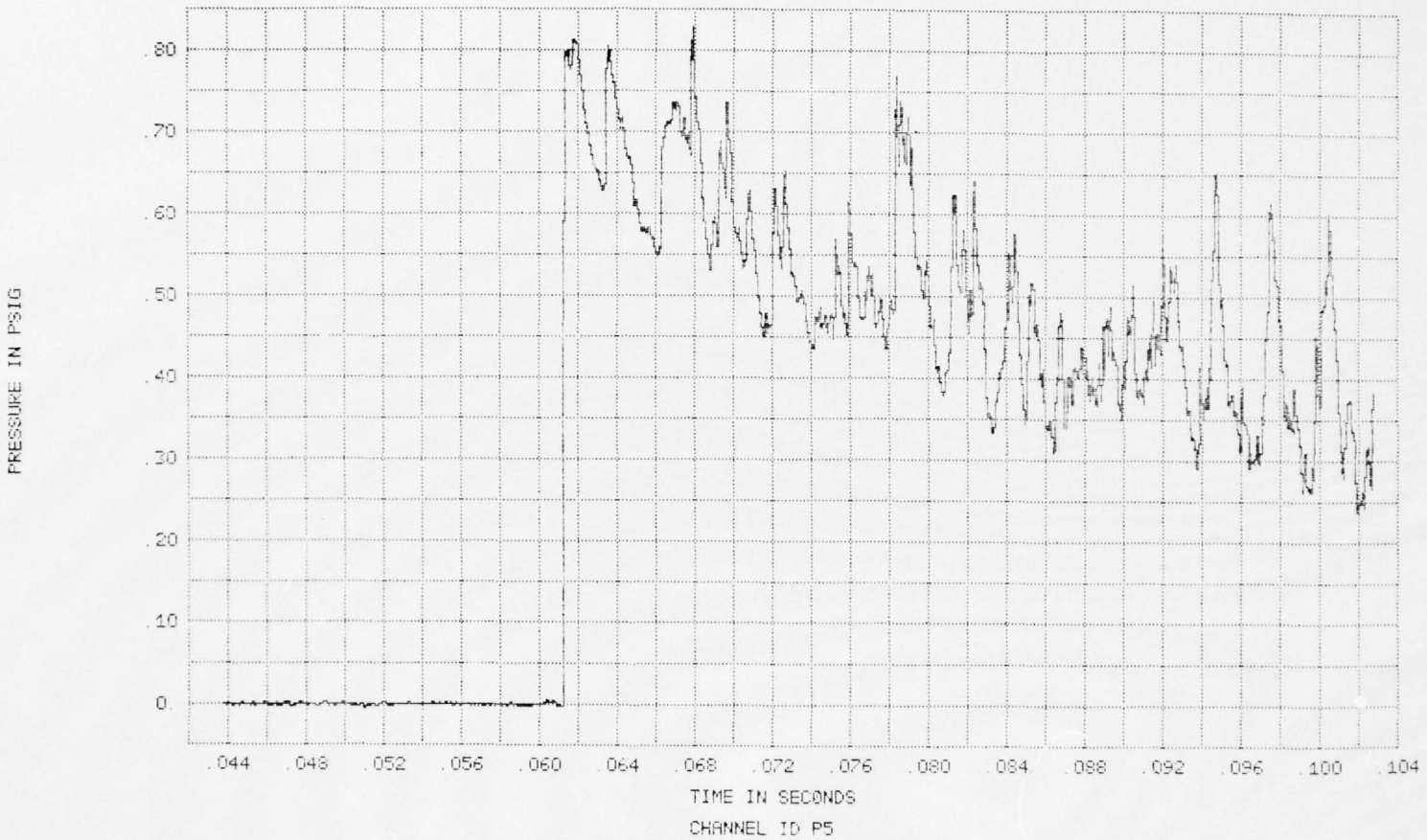


FIGURE 6-8 , SPECIMEN NO. 6 , SHOT NO. 1 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

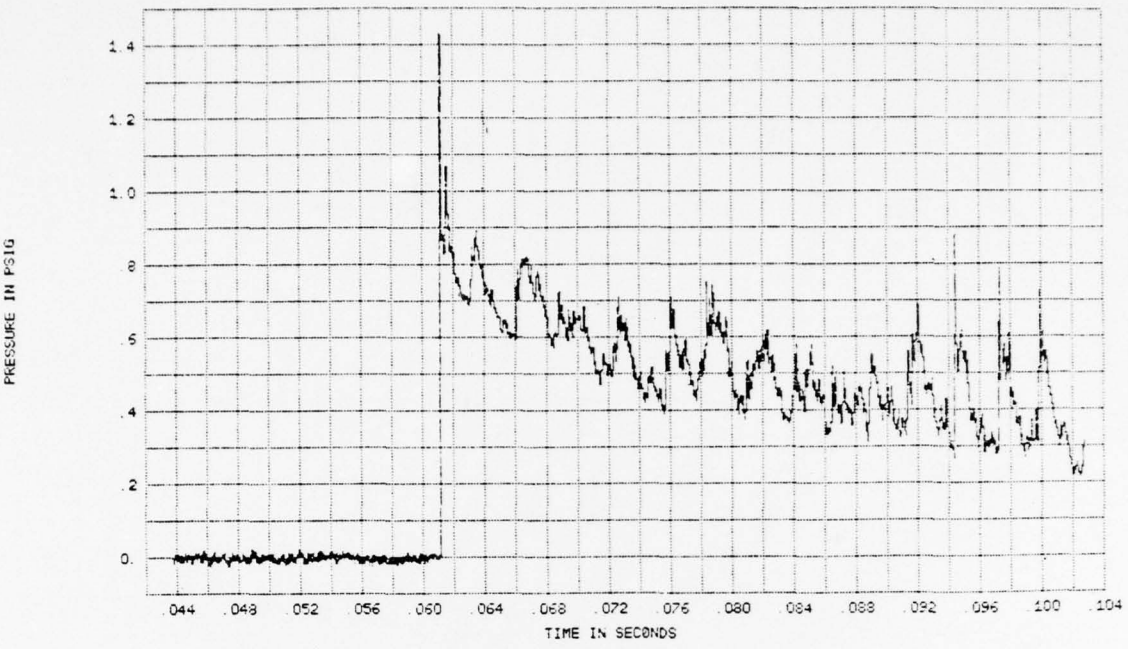


FIGURE 6-9 , SPECIMEN NO. 6 , SHOT NO. 1 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

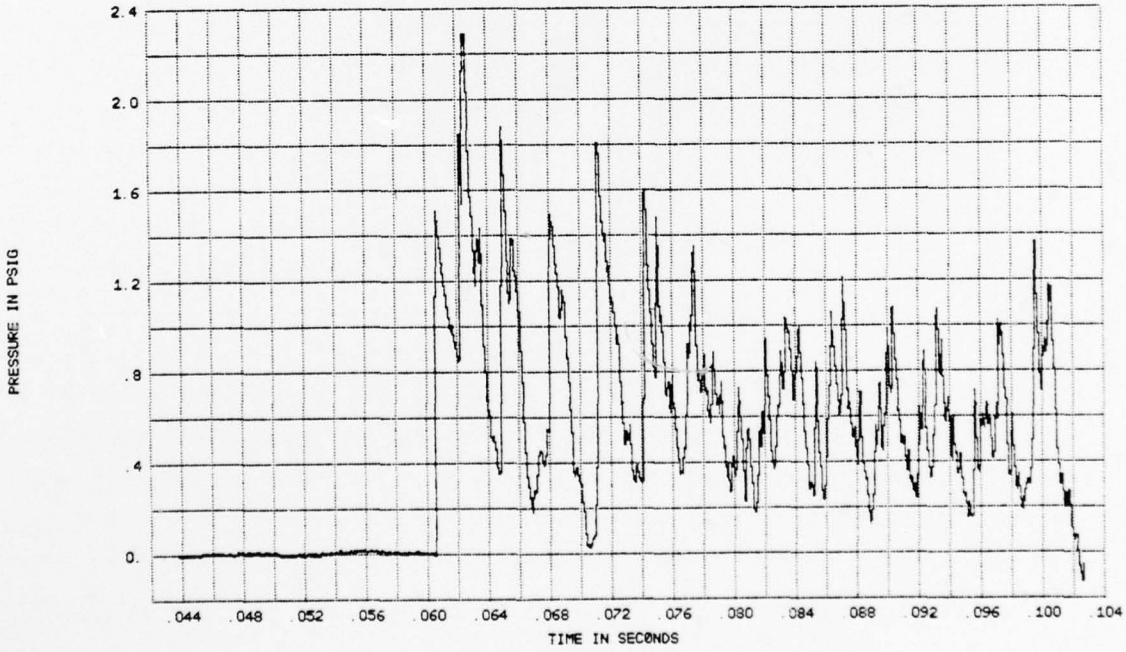


FIGURE 6-10 , SPECIMEN NO. 6 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

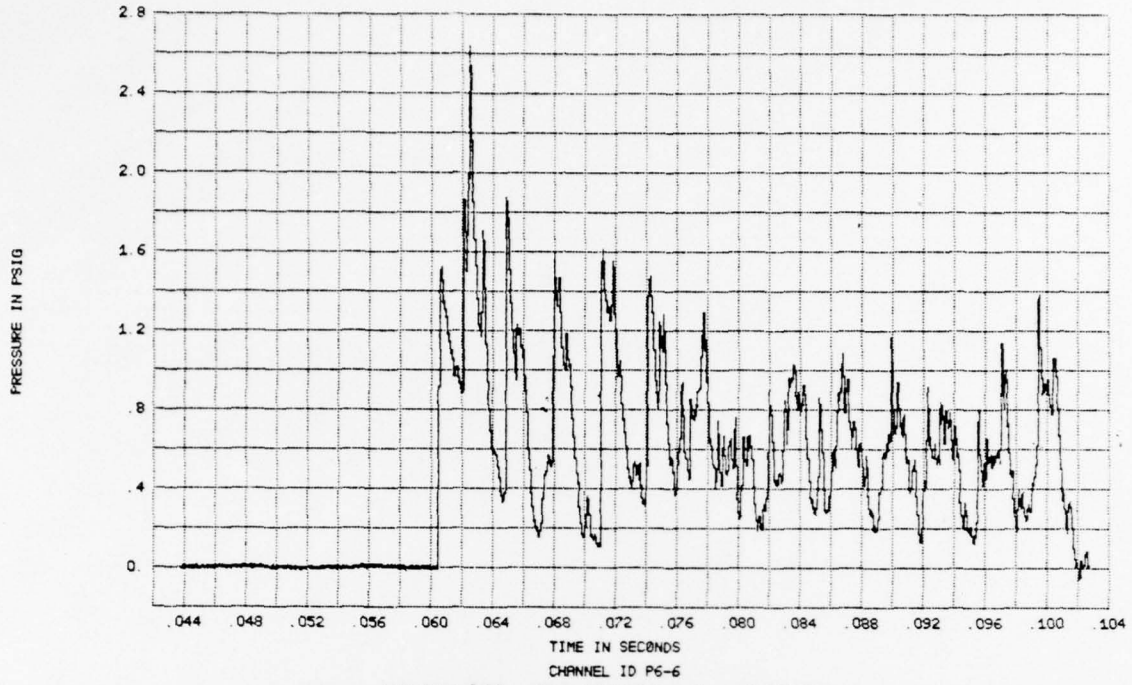


FIGURE 6-11 , SPECIMEN NO. 6 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

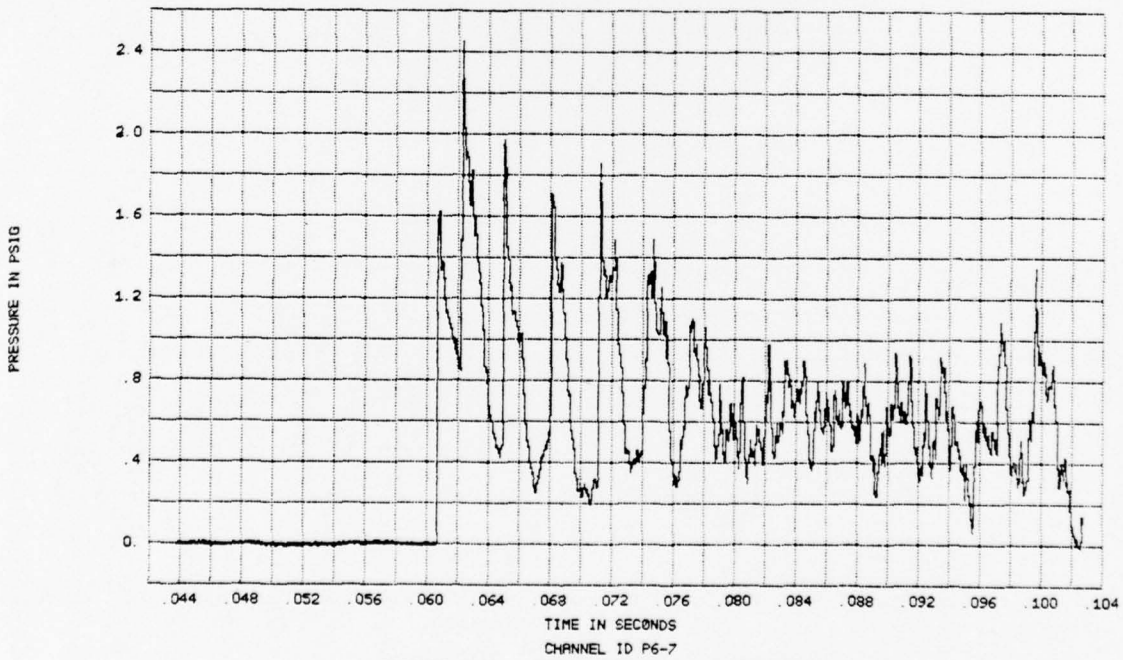


FIGURE 6-12 , SPECIMEN NO. 6 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

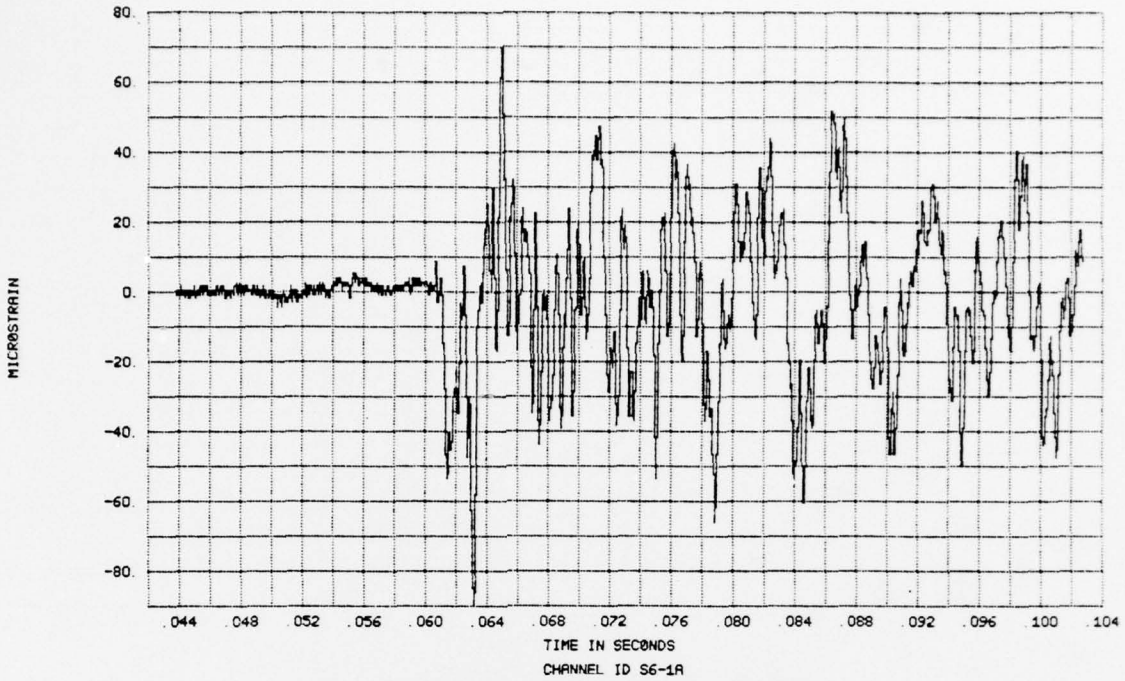


FIGURE 6-13 , SPECIMEN NO. 6 , SHOT NO. 1 , STRAIN TIME HISTORY

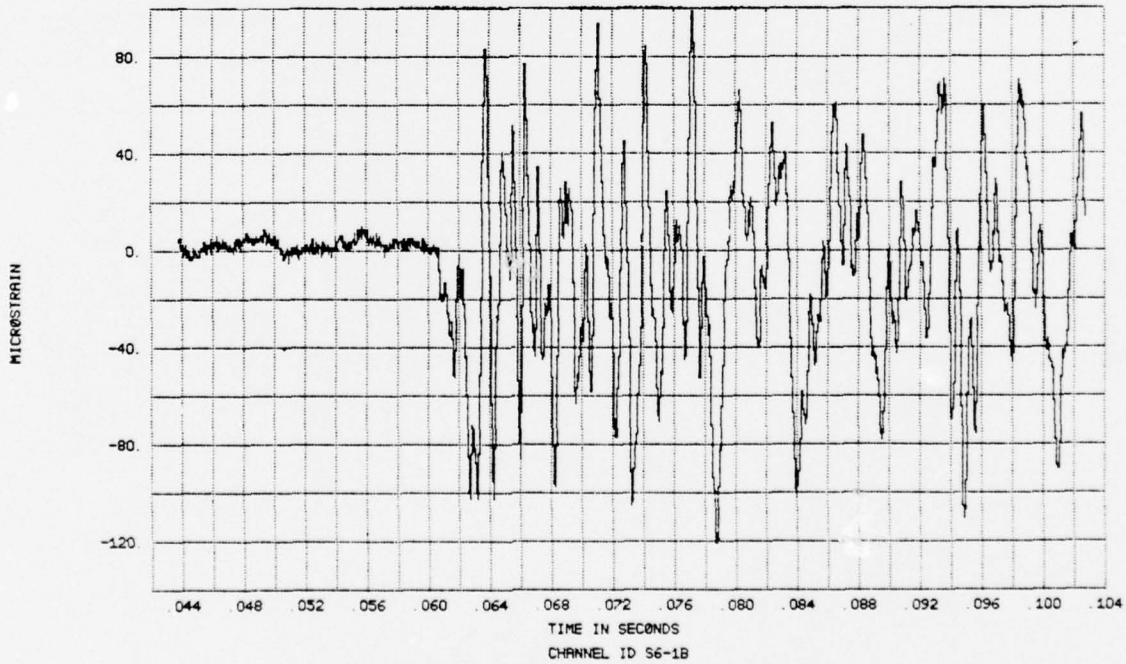


FIGURE 6-14 , SPECIMEN NO. 6 , SHOT NO. 1 , STRAIN TIME HISTORY

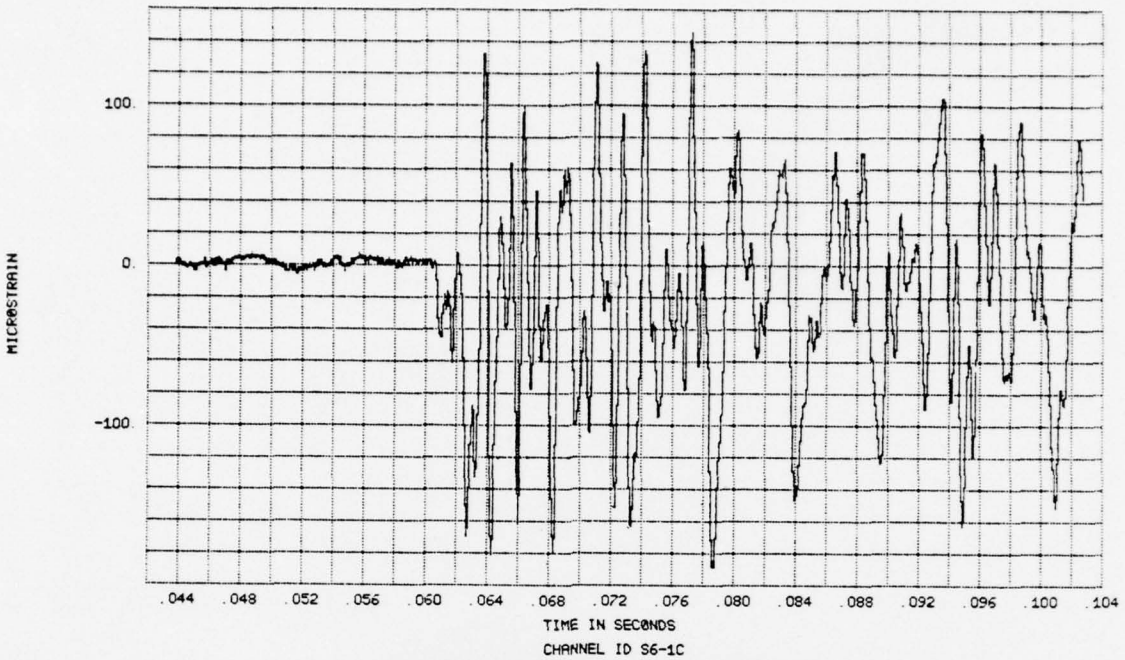


FIGURE 6-15 , SPECIMEN NO. 6 , SHOT NO. 1 , STRAIN TIME HISTORY

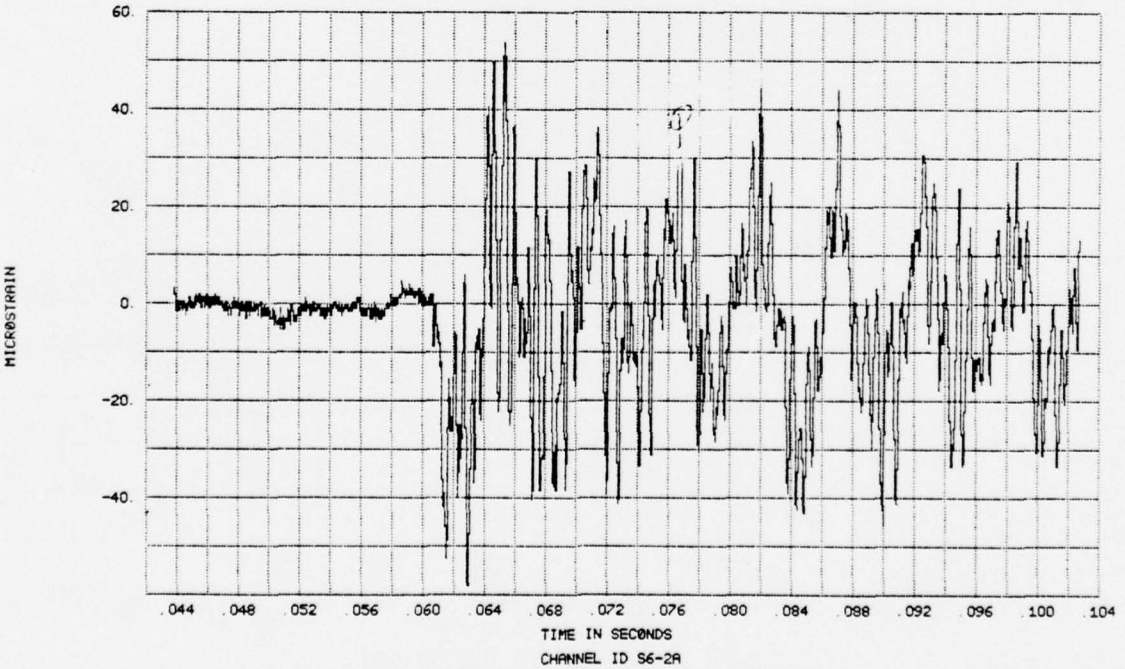


FIGURE 6-16 , SPECIMEN NO. 6 , SHOT NO. 1 , STRAIN TIME HISTORY

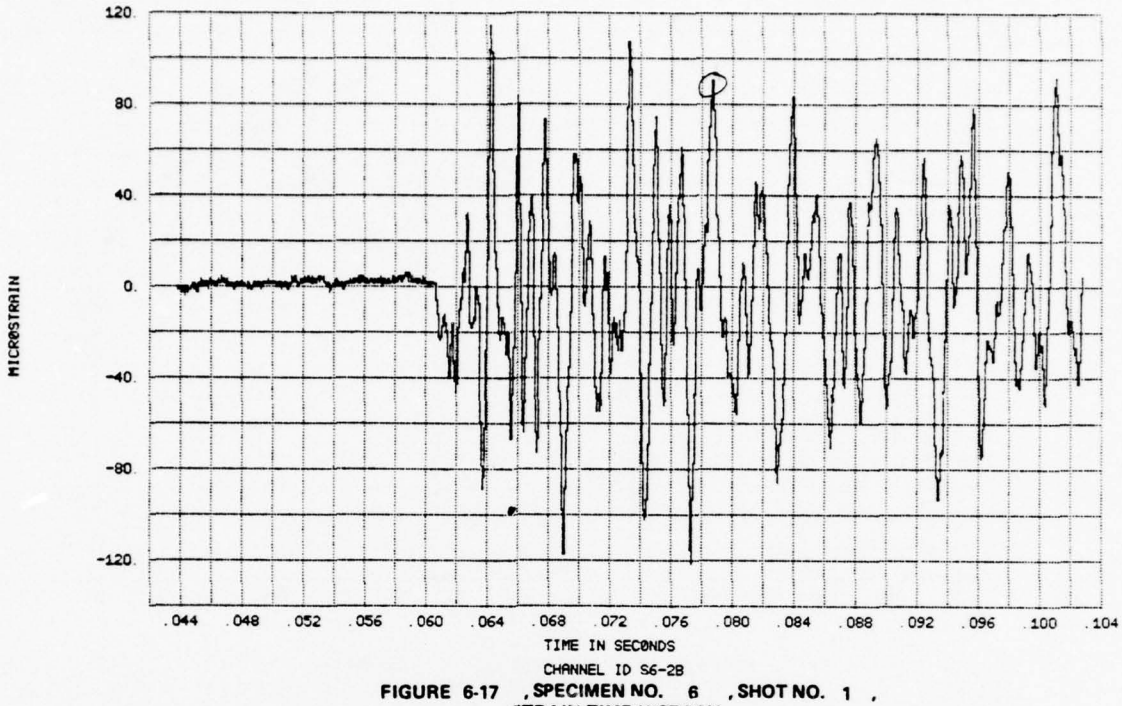


FIGURE 6-17 , SPECIMEN NO. 6 , SHOT NO. 1 , STRAIN TIME HISTORY

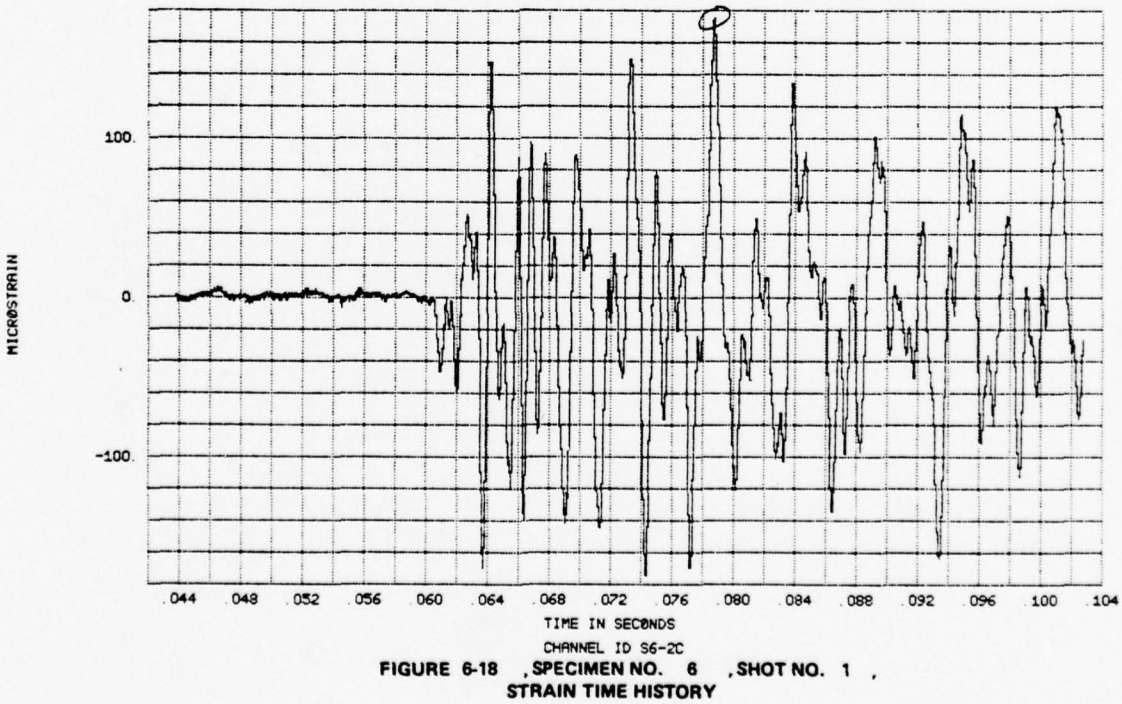


FIGURE 6-18 , SPECIMEN NO. 6 , SHOT NO. 1 , STRAIN TIME HISTORY

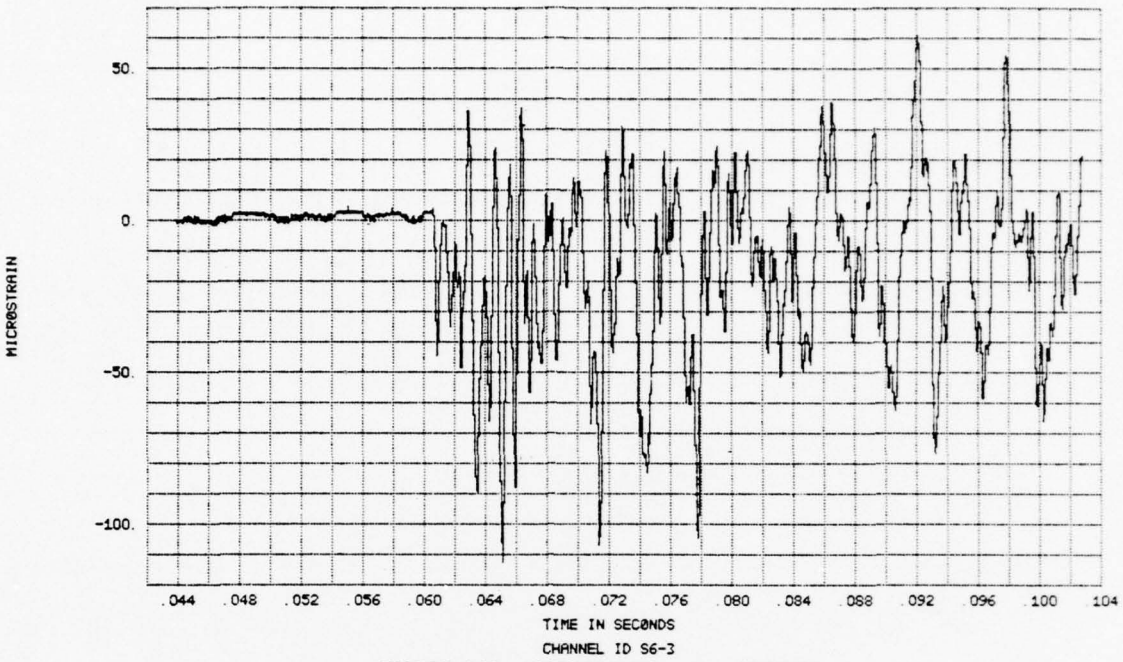


FIGURE 6-19 , SPECIMEN NO. 6 , SHOT NO. 1 , STRAIN TIME HISTORY

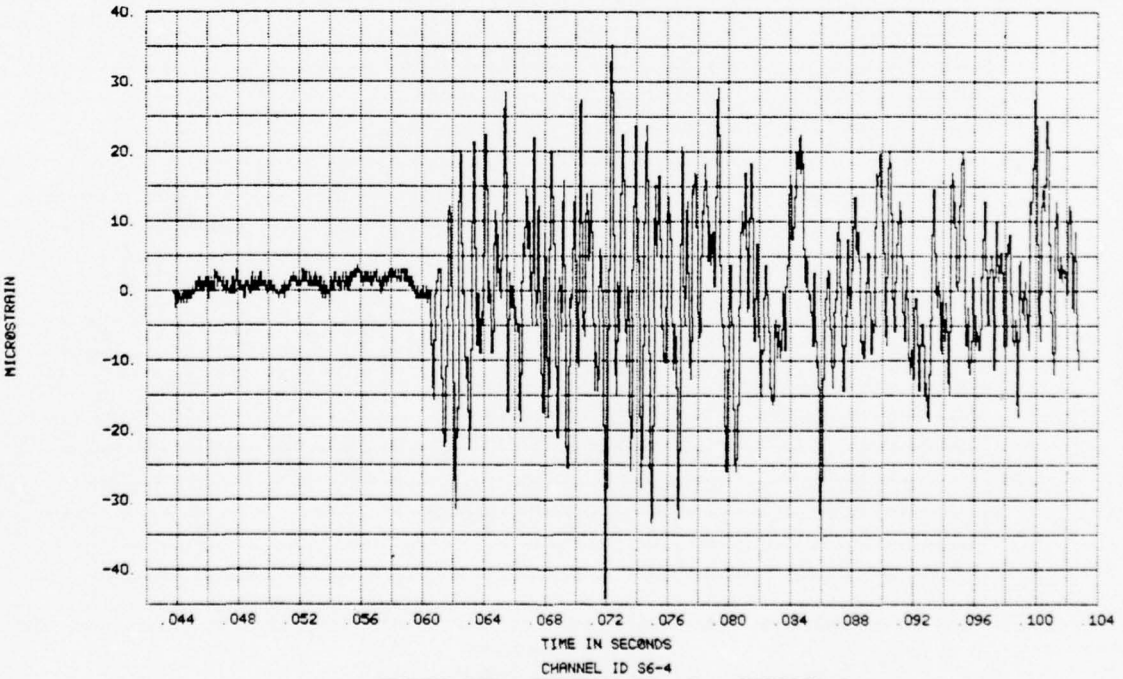


FIGURE 6-20 , SPECIMEN NO. 6 , SHOT NO. 1 , STRAIN TIME HISTORY

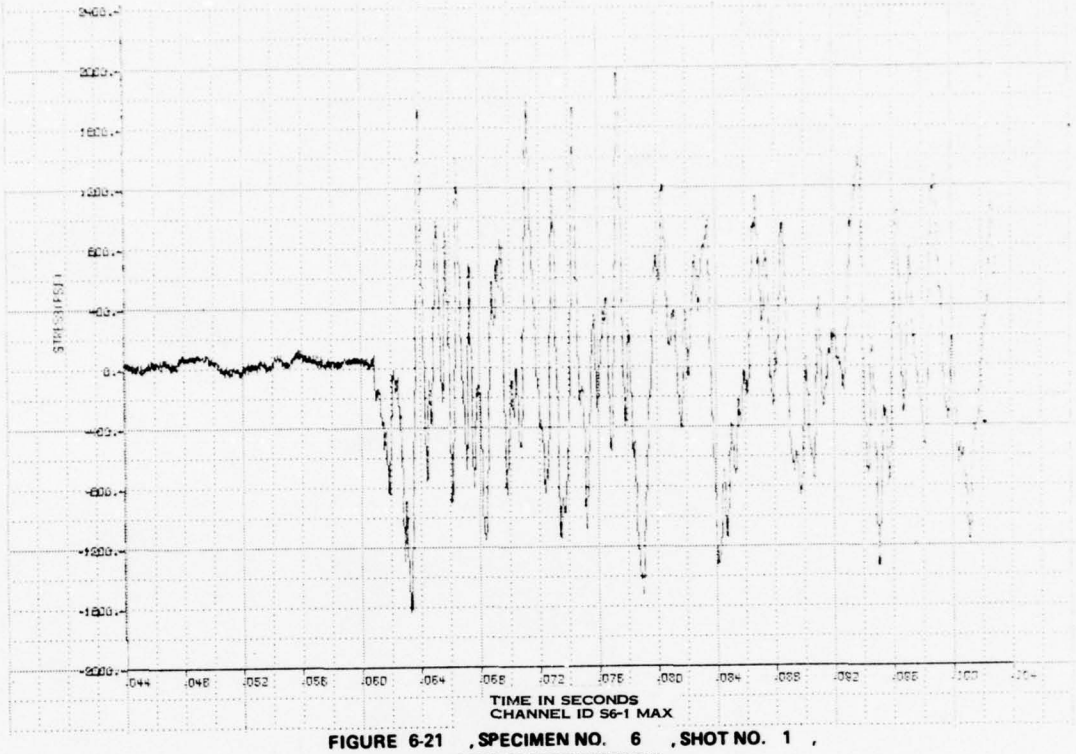


FIGURE 6-21 , SPECIMEN NO. 6 , SHOT NO. 1 ,
STRESS TIME HISTORY

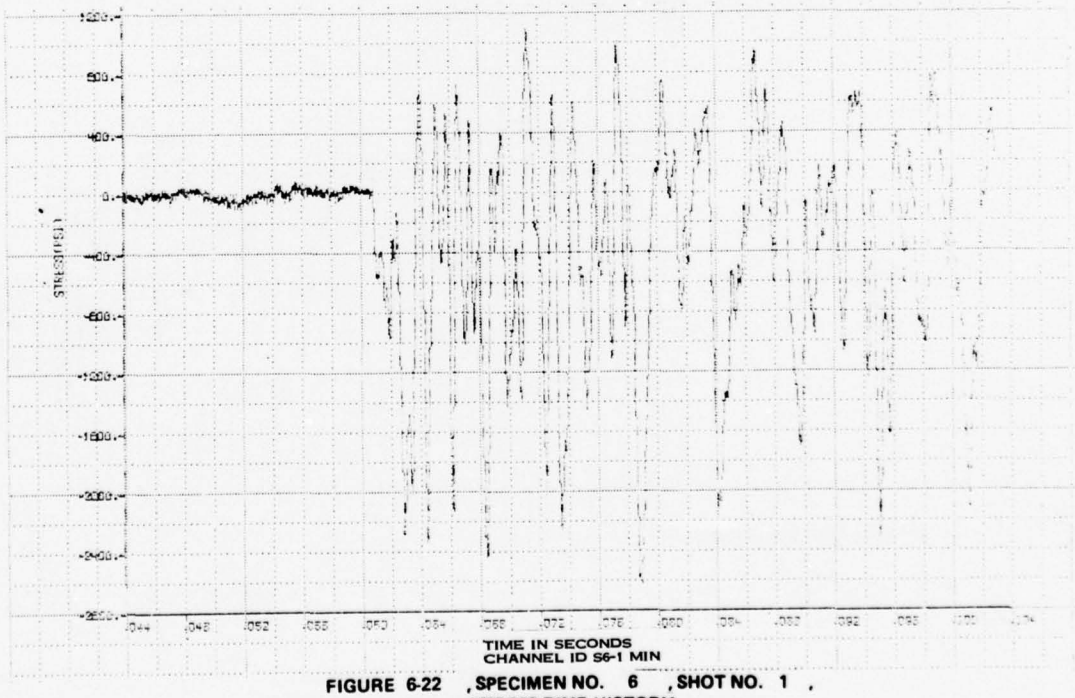


FIGURE 6-22 , SPECIMEN NO. 6 , SHOT NO. 1 ,
STRESS TIME HISTORY

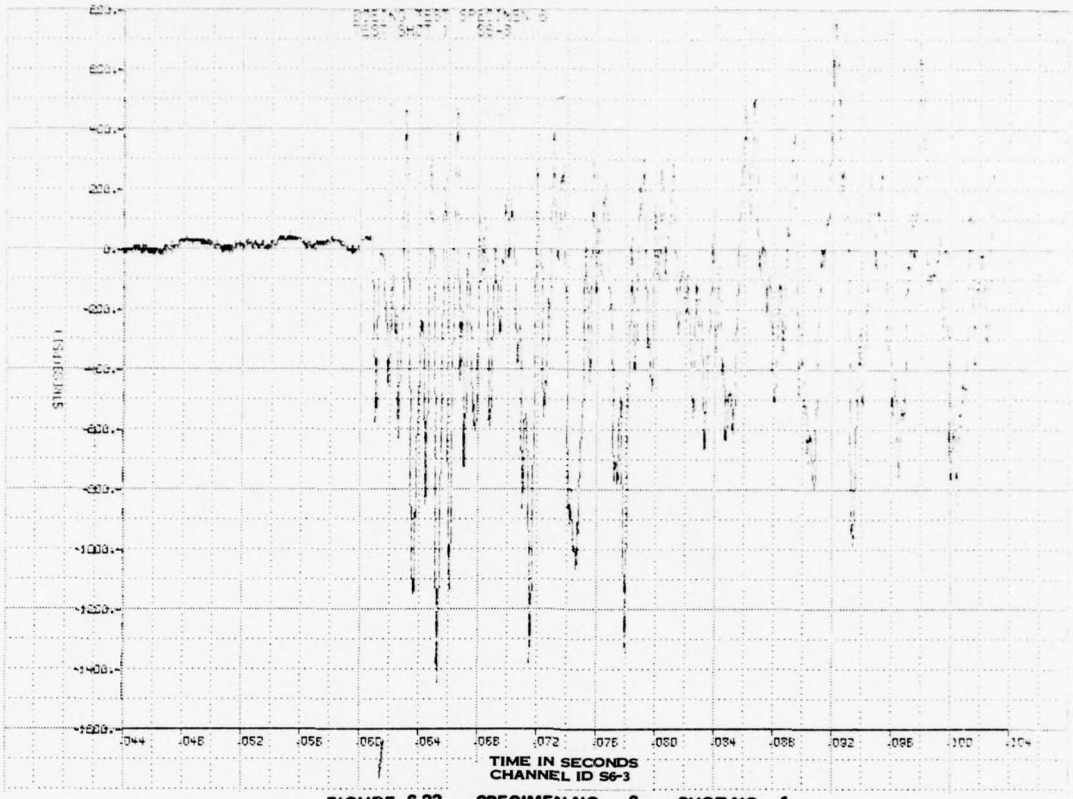


FIGURE 6-23 , SPECIMEN NO. 6 , SHOT NO. 1 ,
STRESS TIME HISTORY

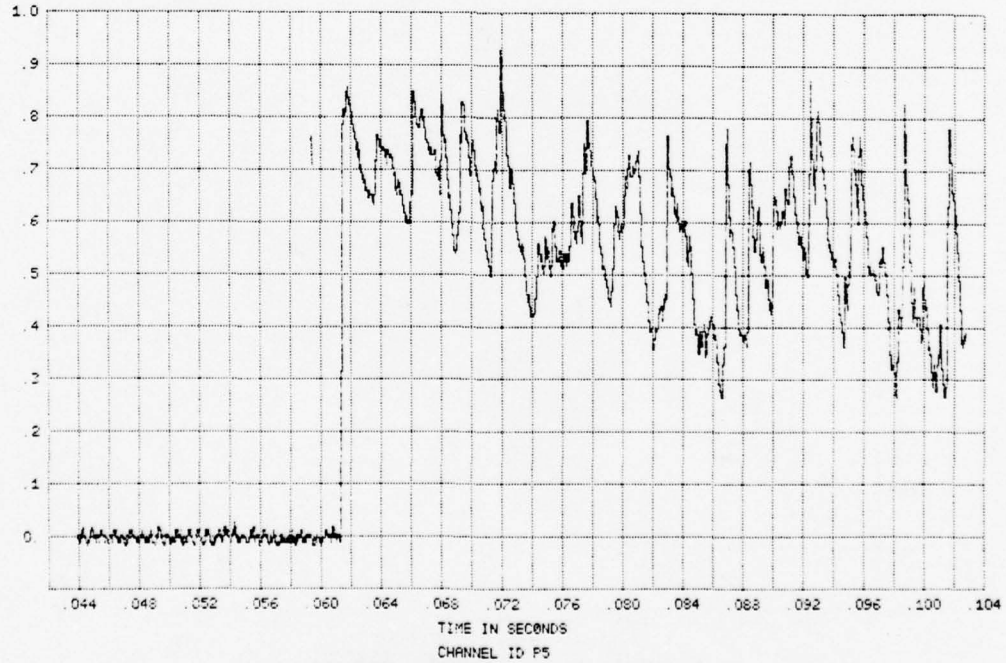


FIGURE 6-24 , SPECIMEN NO. 6 , SHOT NO. 2 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

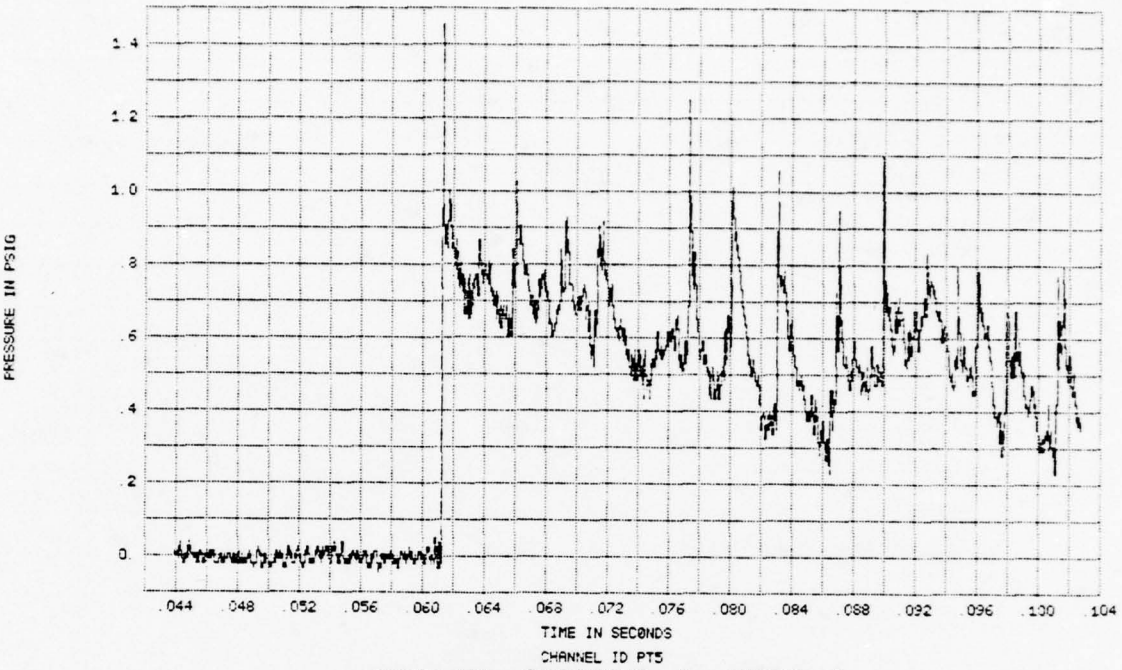


FIGURE 6-25 , SPECIMEN NO. 6 , SHOT NO. 2 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

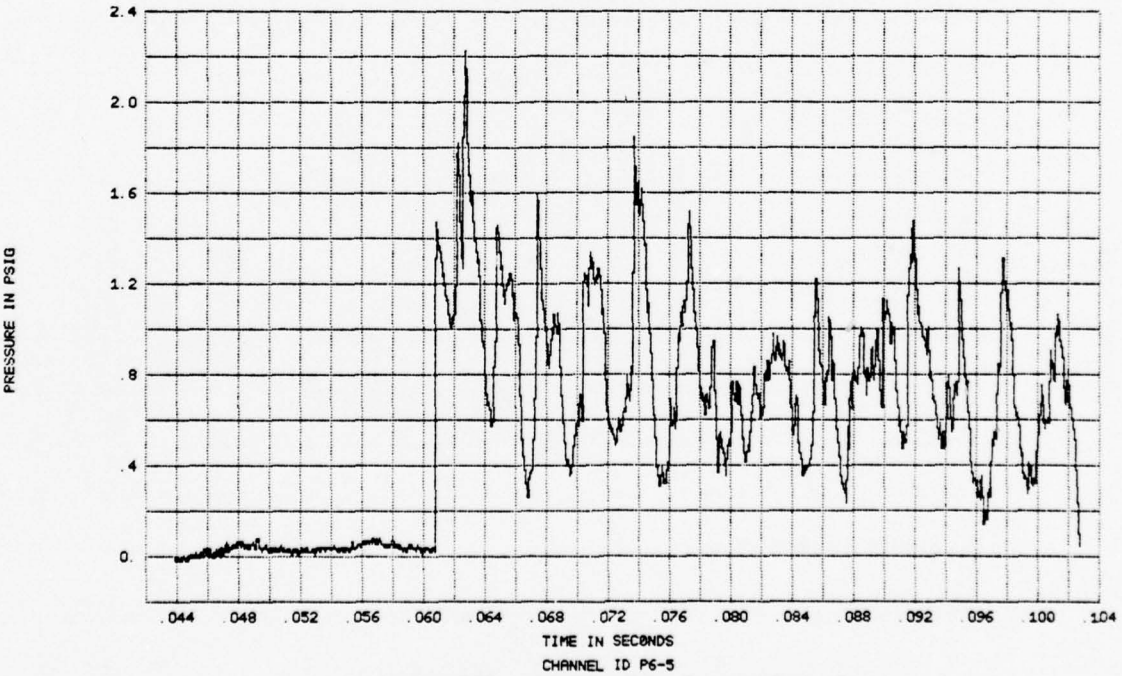


FIGURE 6-26 , SPECIMEN NO. 6 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

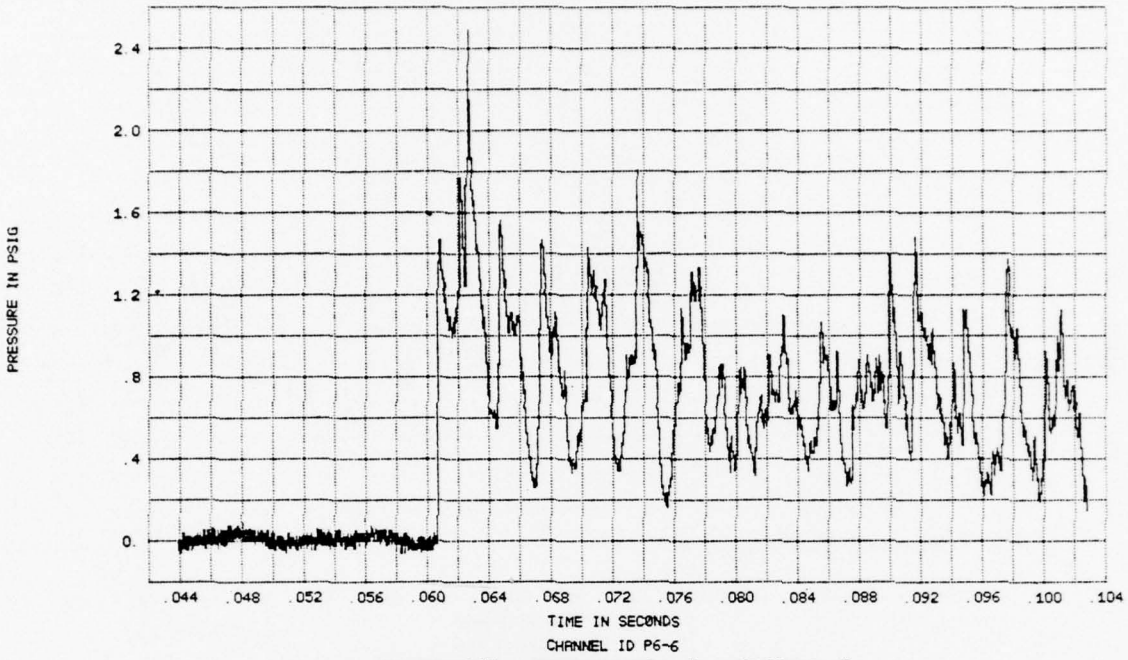


FIGURE 6-27 , SPECIMEN NO. 6 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

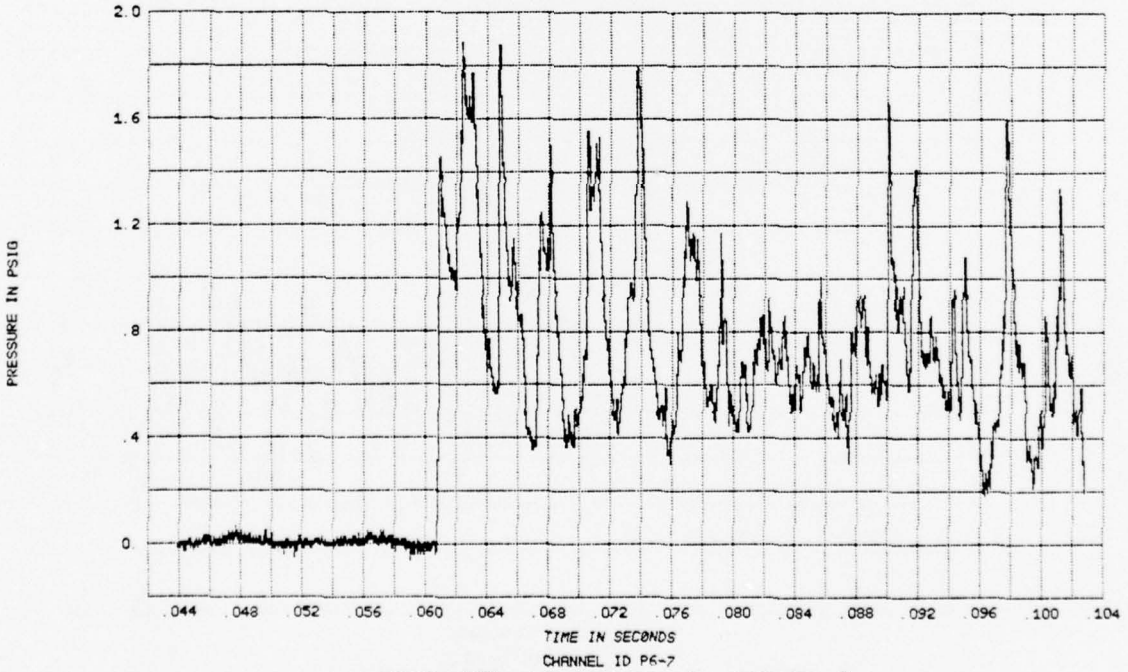


FIGURE 6-28 , SPECIMEN NO. 6 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

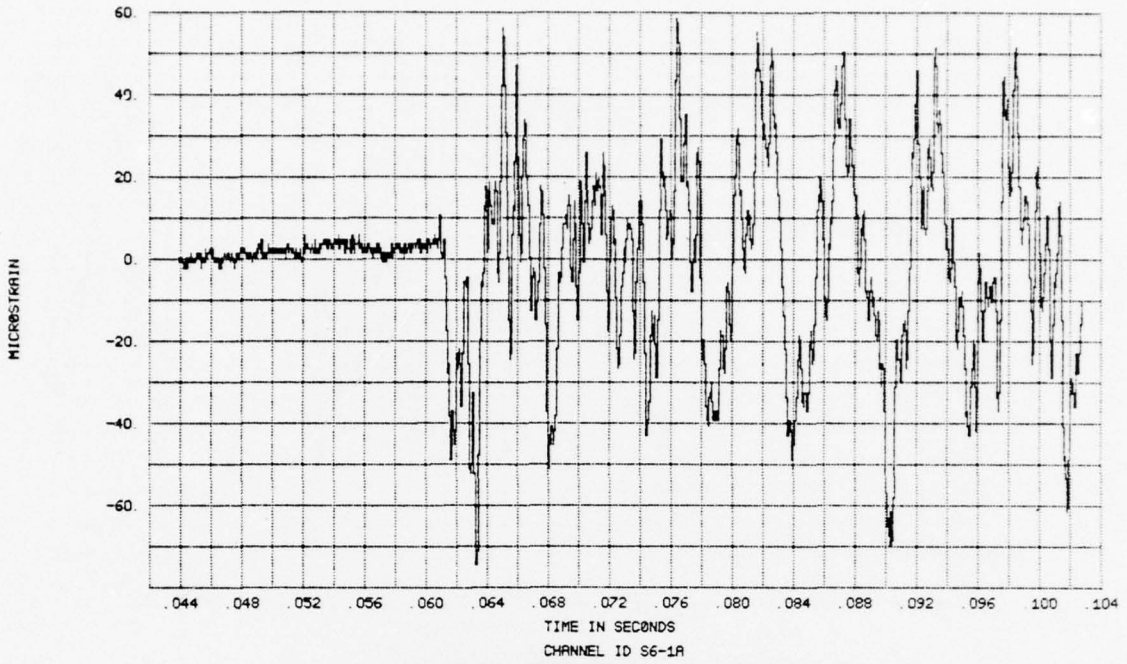


FIGURE 6-29 , SPECIMEN NO. 6 , SHOT NO. 2 ,
STRAIN TIME HISTORY

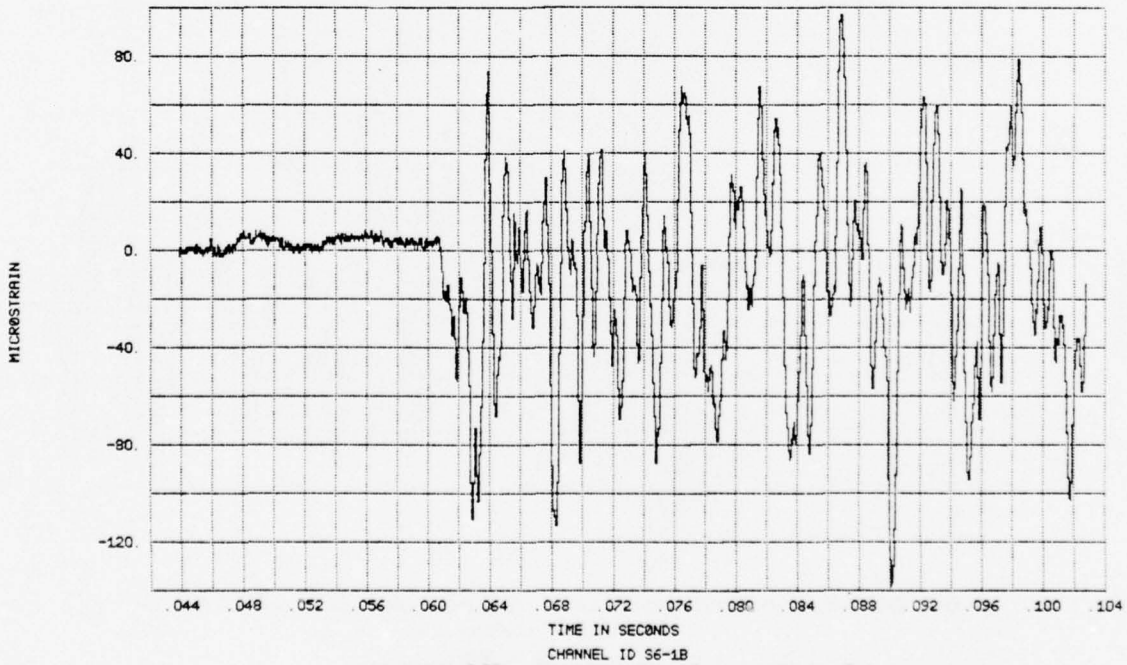


FIGURE 6-30 , SPECIMEN NO. 6 , SHOT NO. 2 ,
STRAIN TIME HISTORY

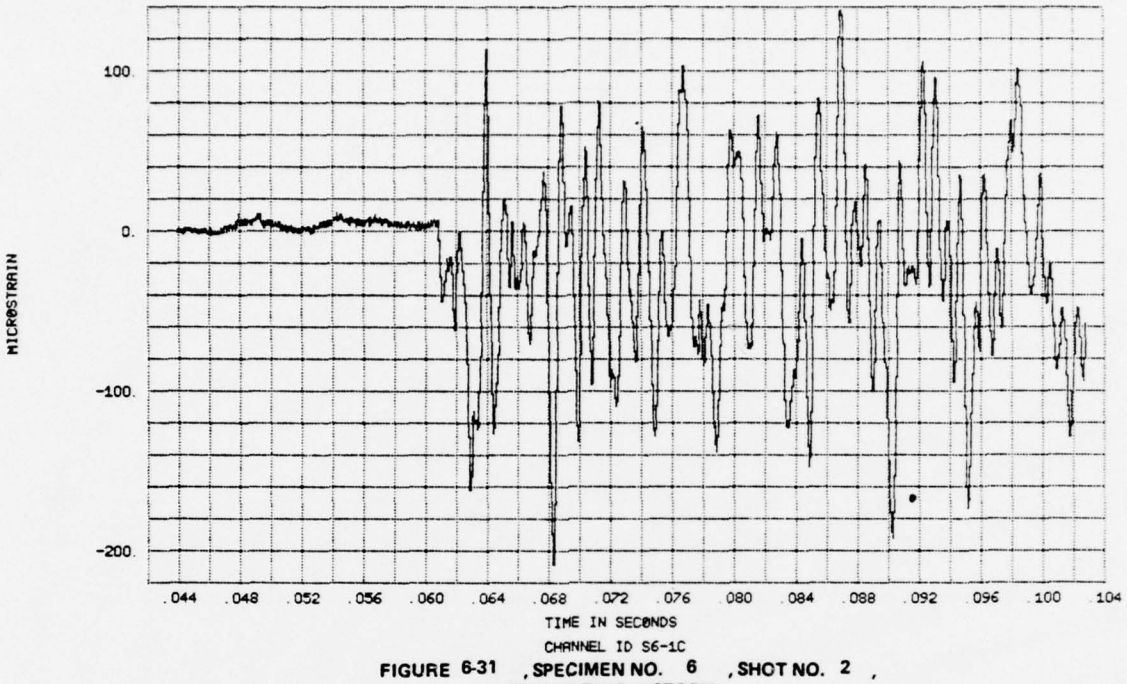


FIGURE 6-31 , SPECIMEN NO. 6 , SHOT NO. 2 ,
STRAIN TIME HISTORY

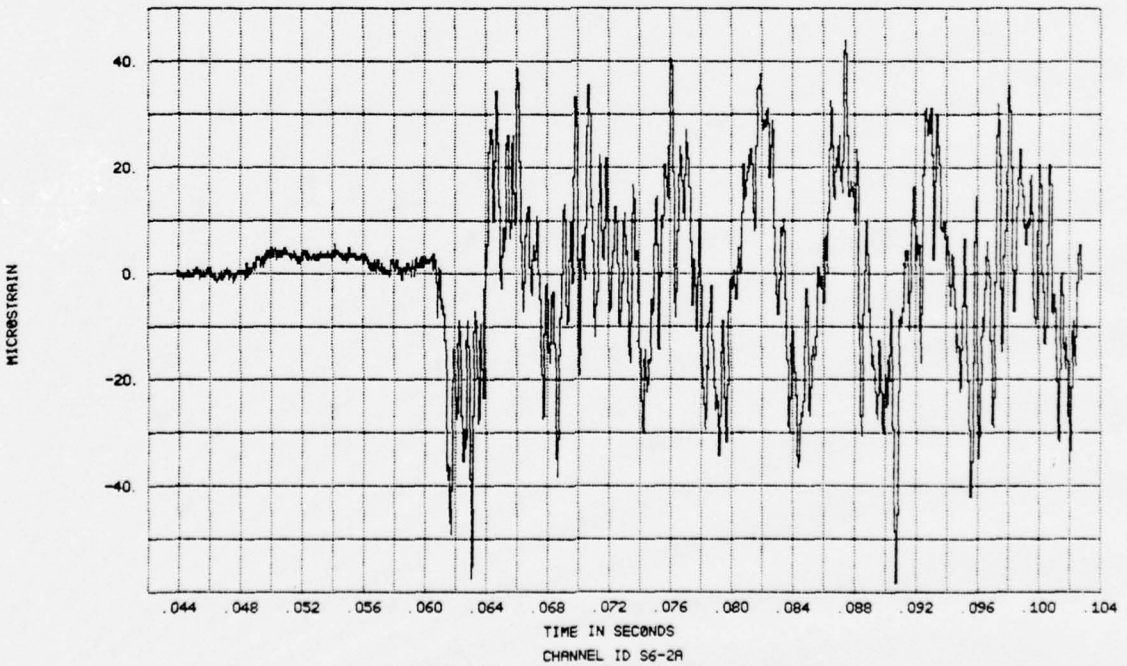


FIGURE 6-32 , SPECIMEN NO. 6 , SHOT NO. 2 ,
STRAIN TIME HISTORY

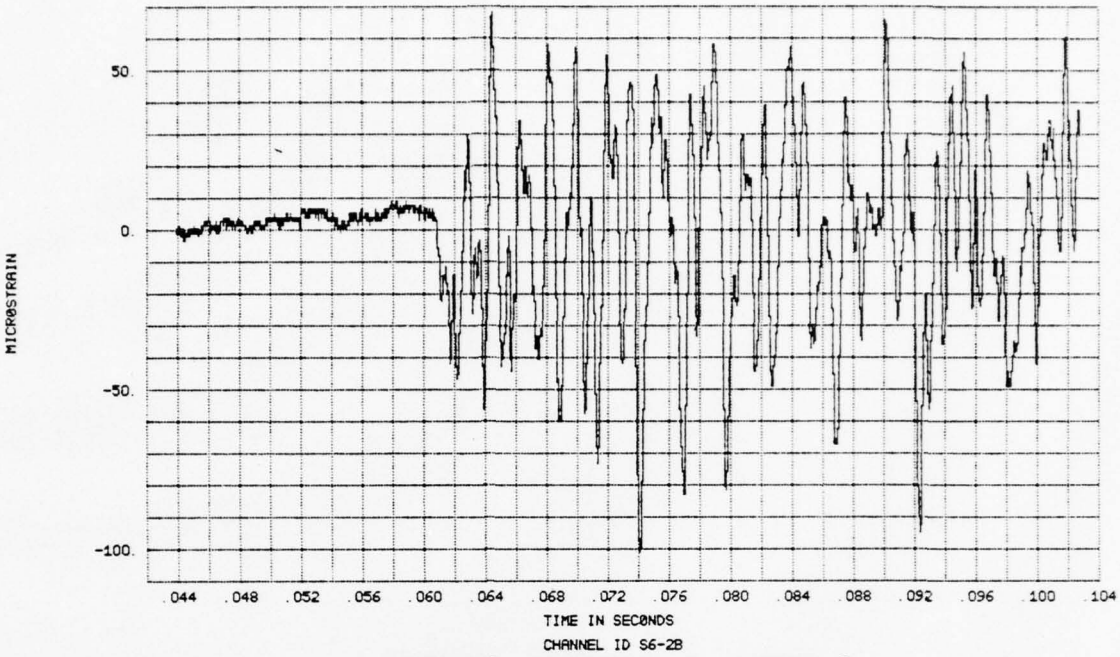


FIGURE 6-33 , SPECIMEN NO. 6 , SHOT NO. 2 , STRAIN TIME HISTORY

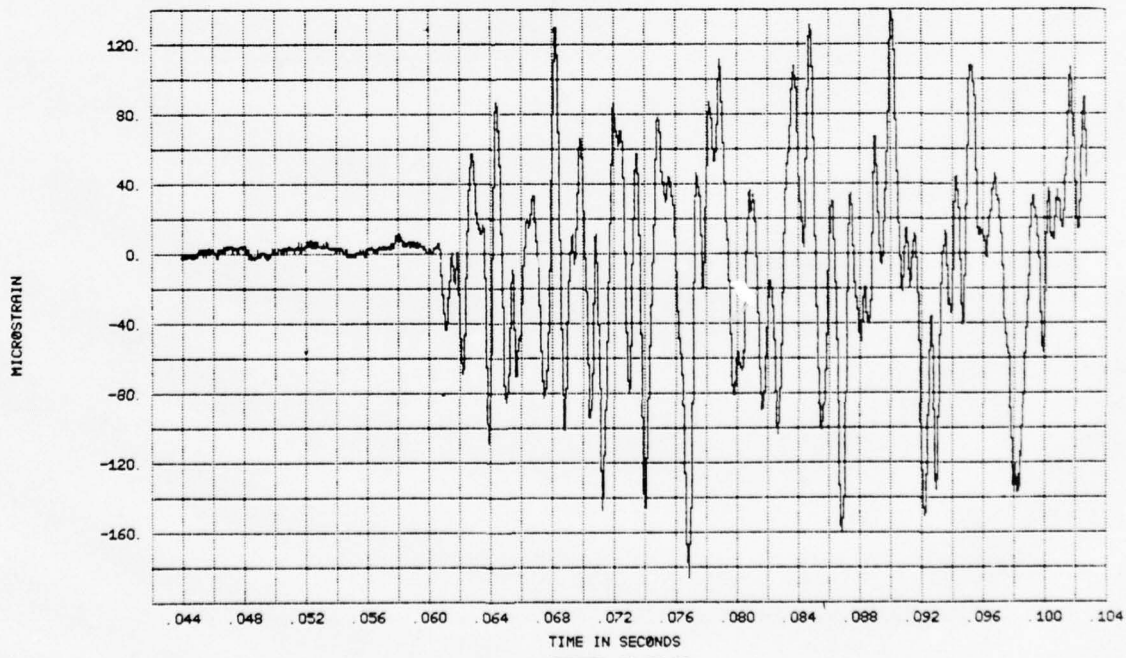


FIGURE 6-34 , SPECIMEN NO. 6 , SHOT NO. 2 , STRAIN TIME HISTORY

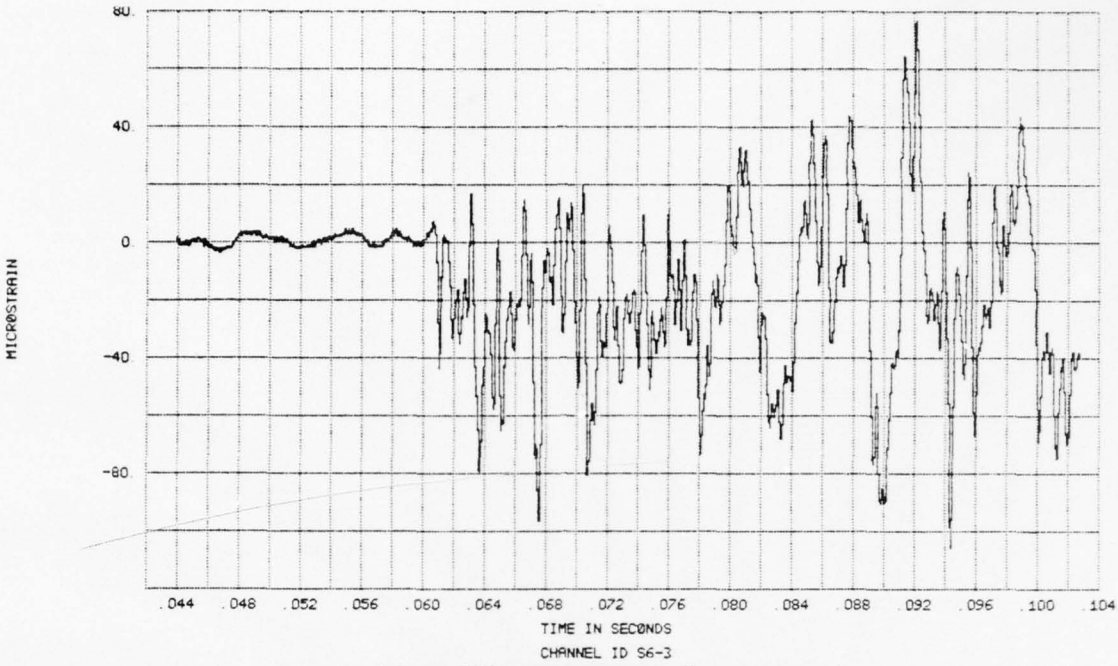


FIGURE 6-35 , SPECIMEN NO. 6 , SHOT NO. 2 , STRAIN TIME HISTORY

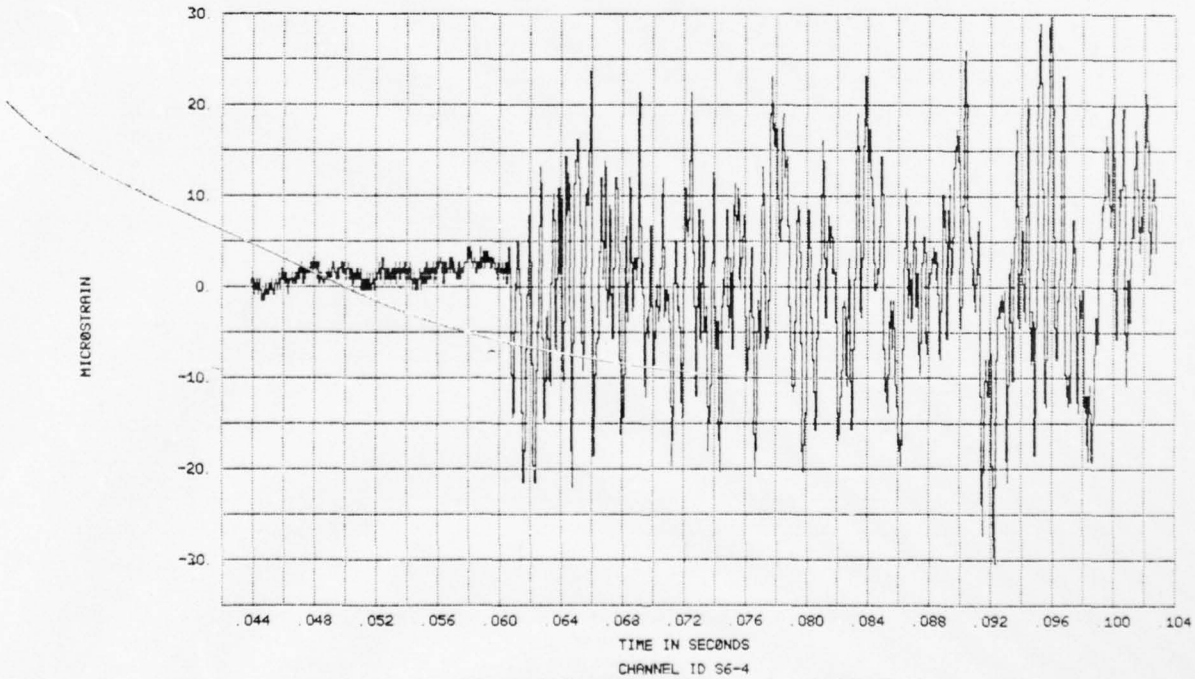


FIGURE 6-36 , SPECIMEN NO. 6 , SHOT NO. 2 , STRAIN TIME HISTORY

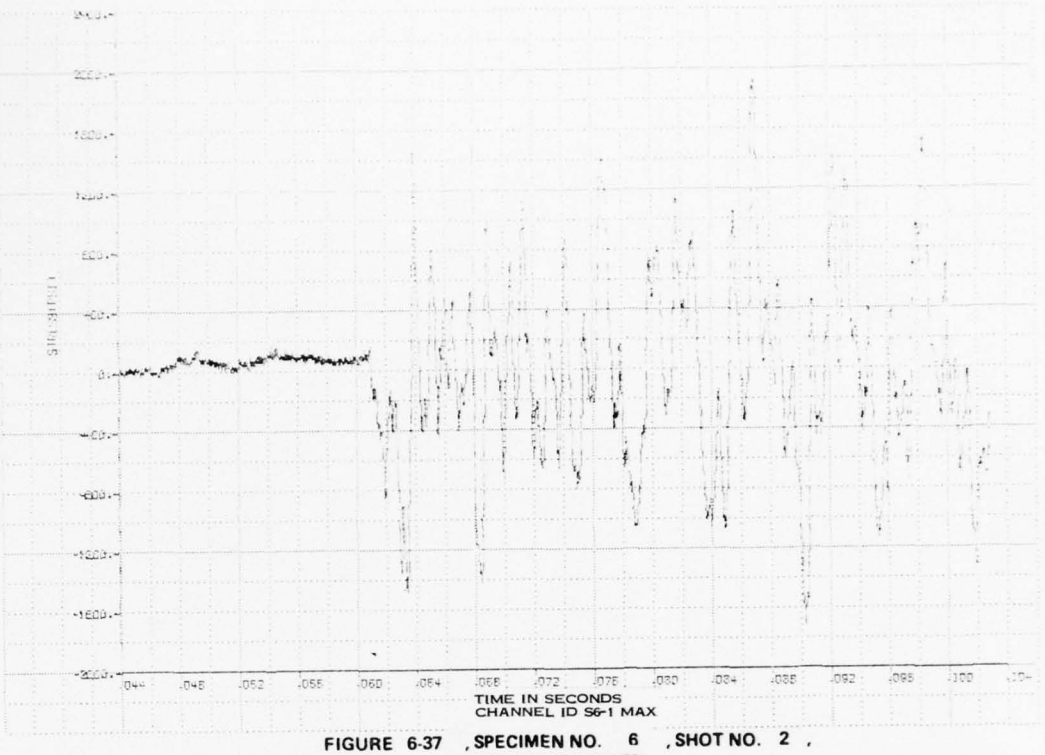


FIGURE 6-37 , SPECIMEN NO. 6 , SHOT NO. 2 ,
STRESS TIME HISTORY

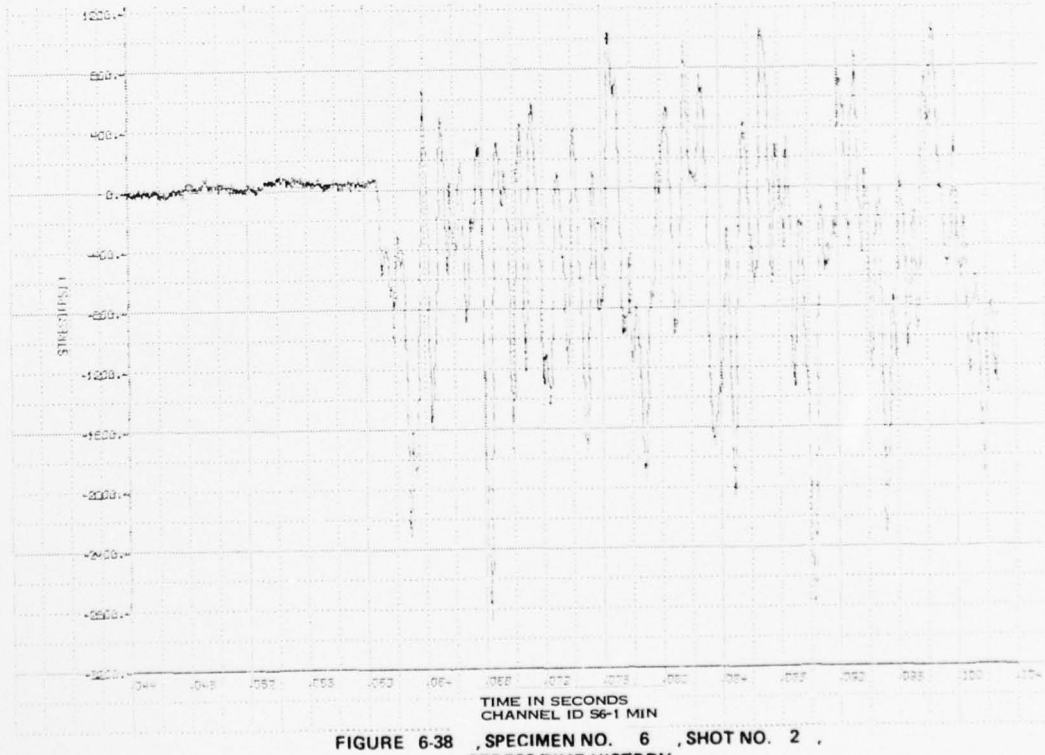


FIGURE 6-38 , SPECIMEN NO. 6 , SHOT NO. 2 ,
STRESS TIME HISTORY

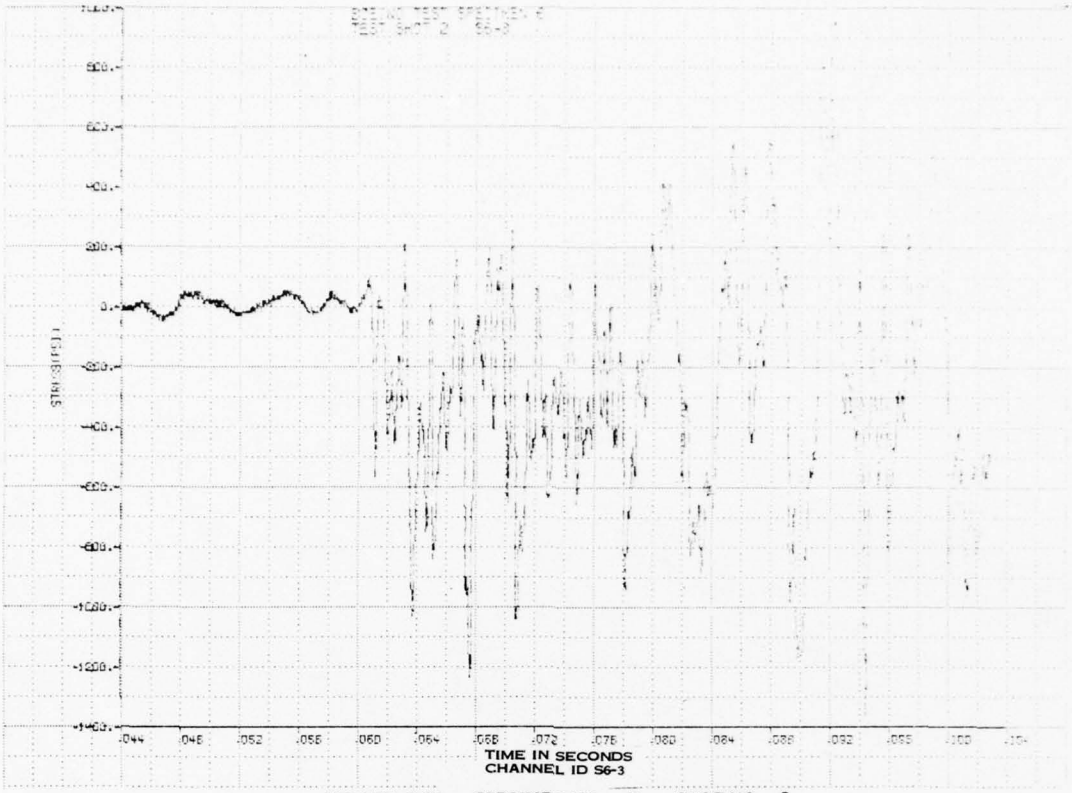


FIGURE 6-39 , SPECIMEN NO. 6 , SHOT NO. 2 ,
STRESS TIME HISTORY

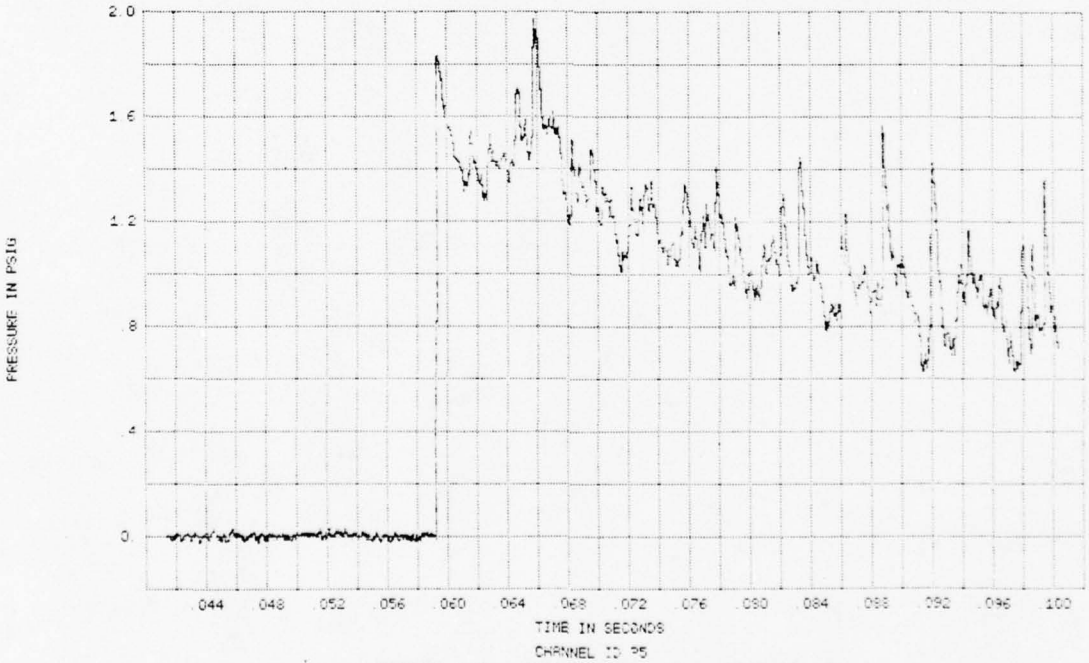


FIGURE 6-40 , SPECIMEN NO. 6 , SHOT NO. 3 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

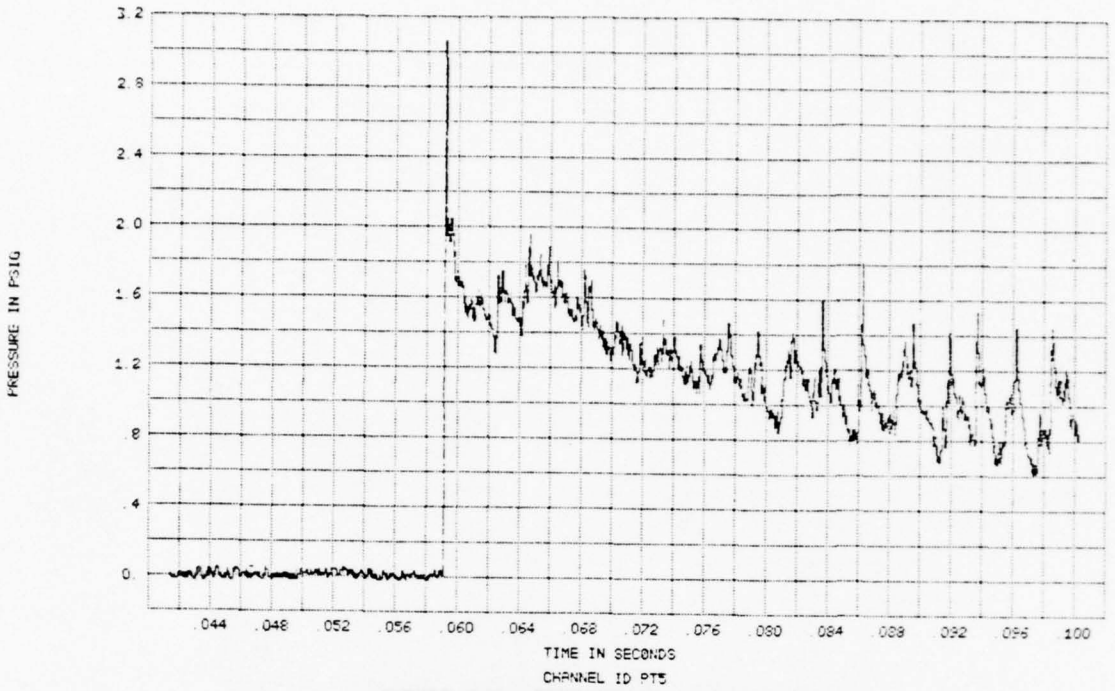


FIGURE 6-41 , SPECIMEN NO. 6 , SHOT NO. 3 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

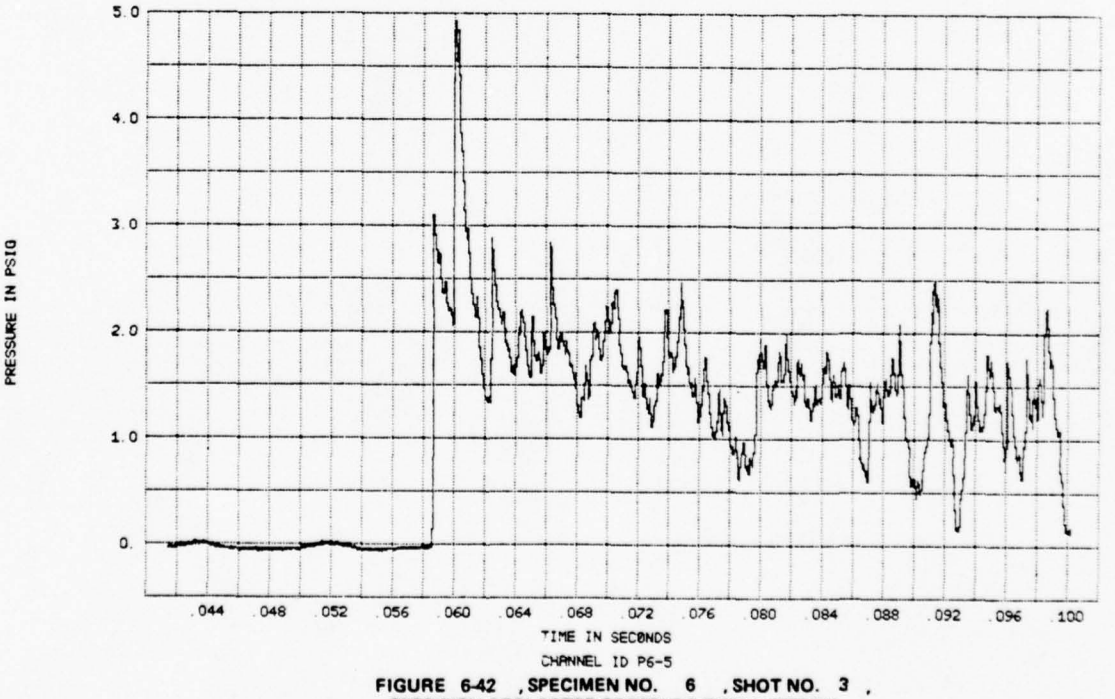


FIGURE 6-42 , SPECIMEN NO. 6 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

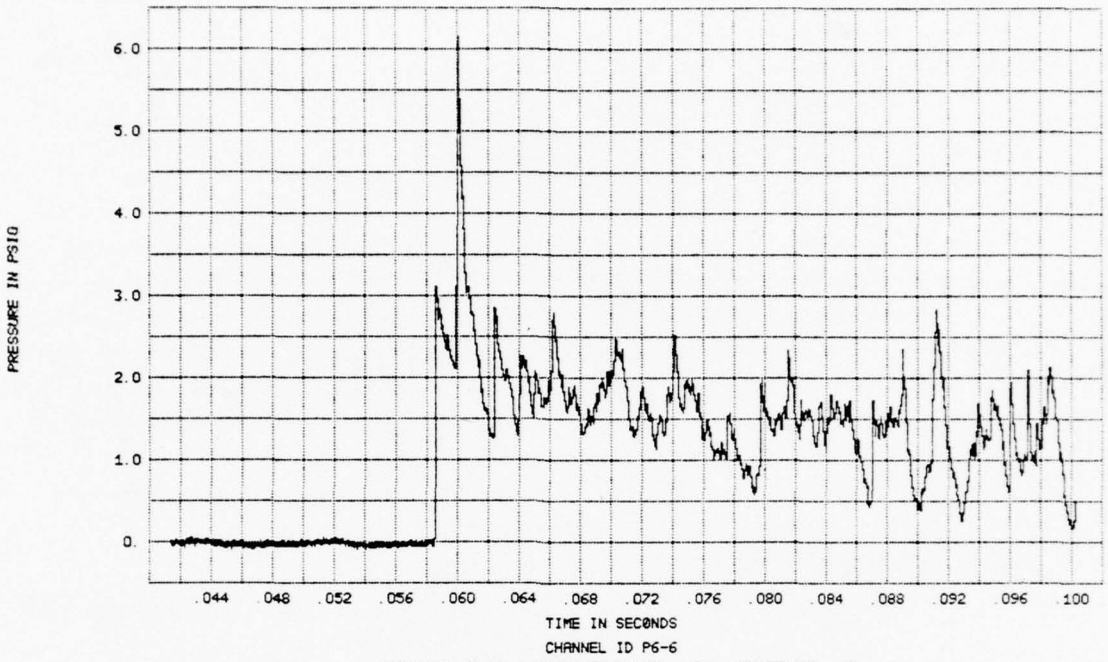


FIGURE 6-43 , SPECIMEN NO. 6 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

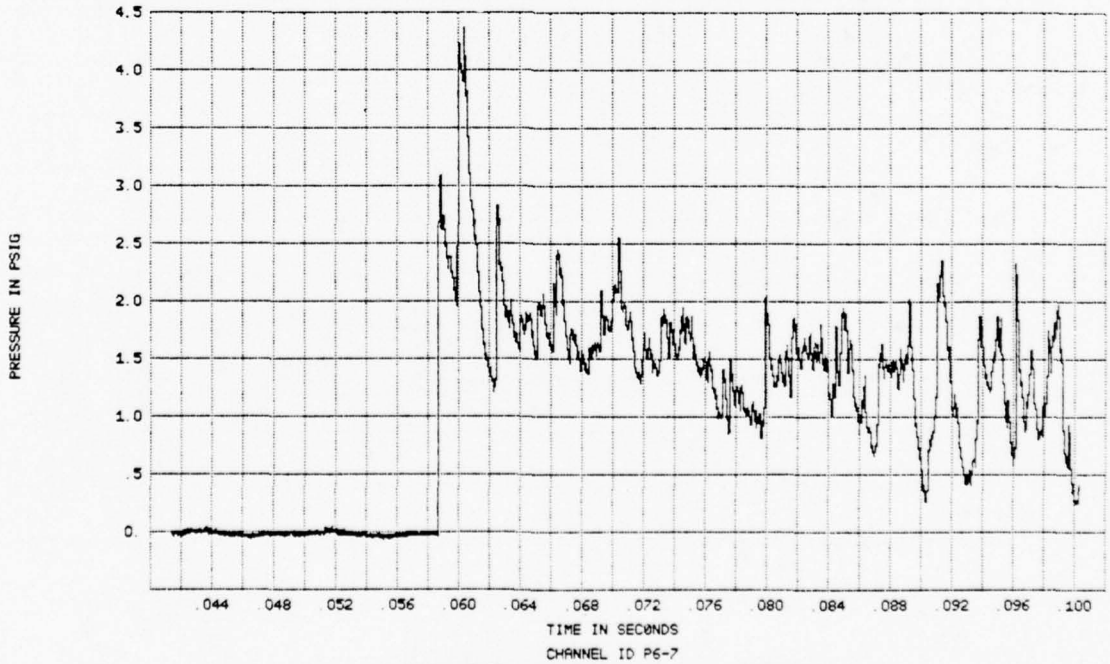


FIGURE 6-44 , SPECIMEN NO. 6 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

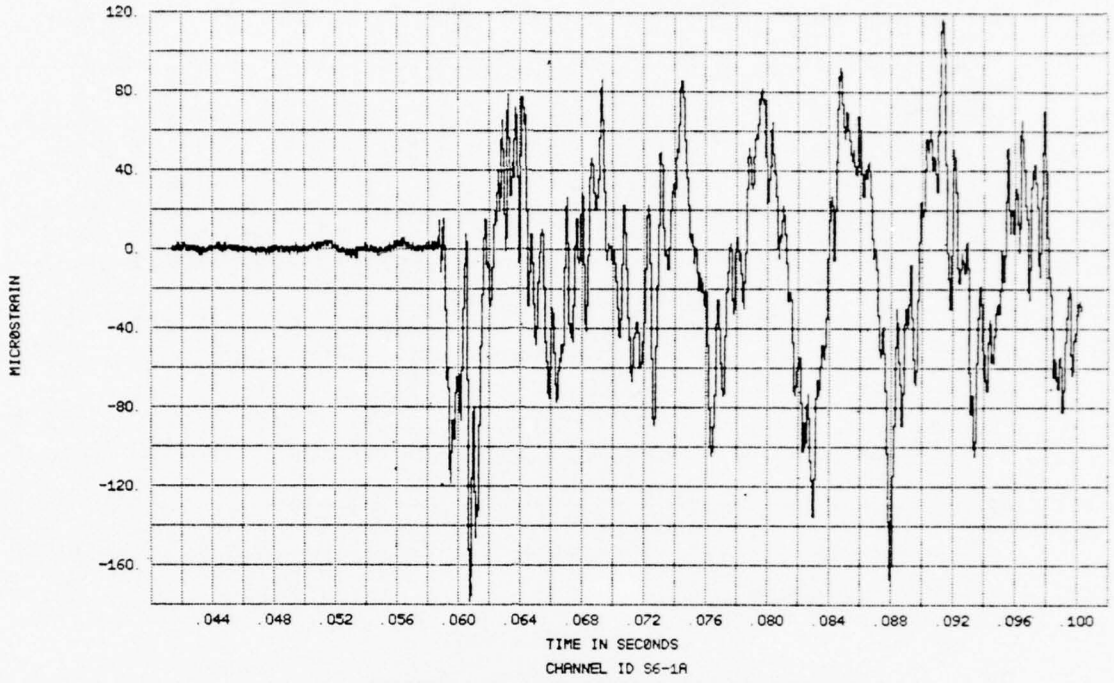


FIGURE 6-45 , SPECIMEN NO. 6 , SHOT NO. 3 , STRAIN TIME HISTORY

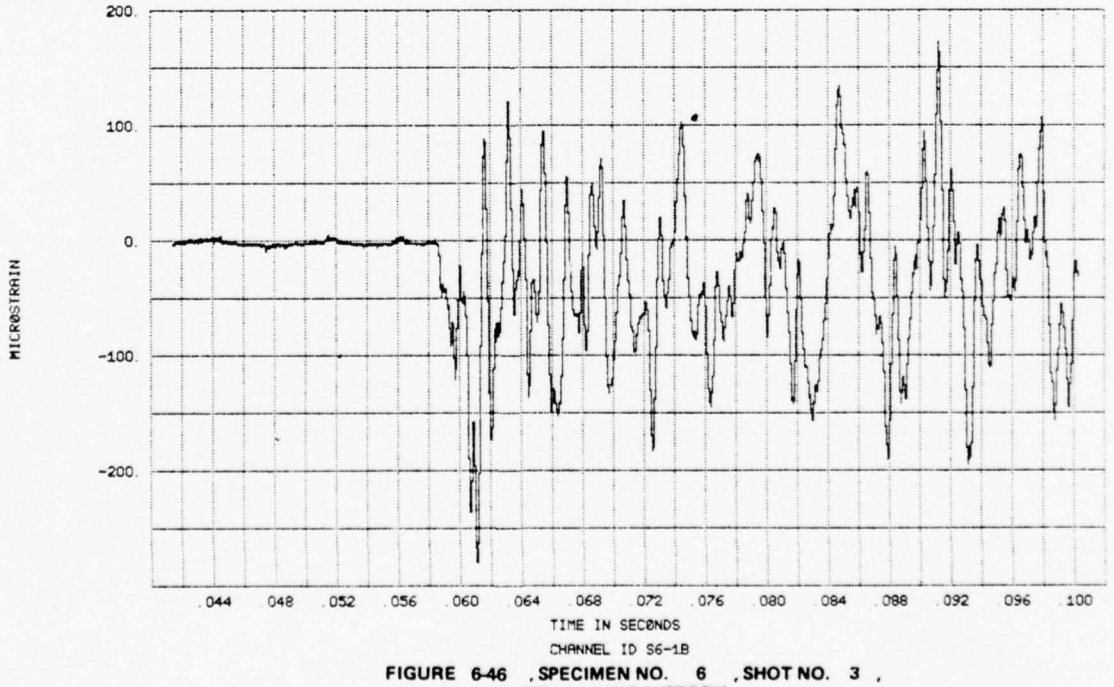


FIGURE 6-46 , SPECIMEN NO. 6 , SHOT NO. 3 , STRAIN TIME HISTORY

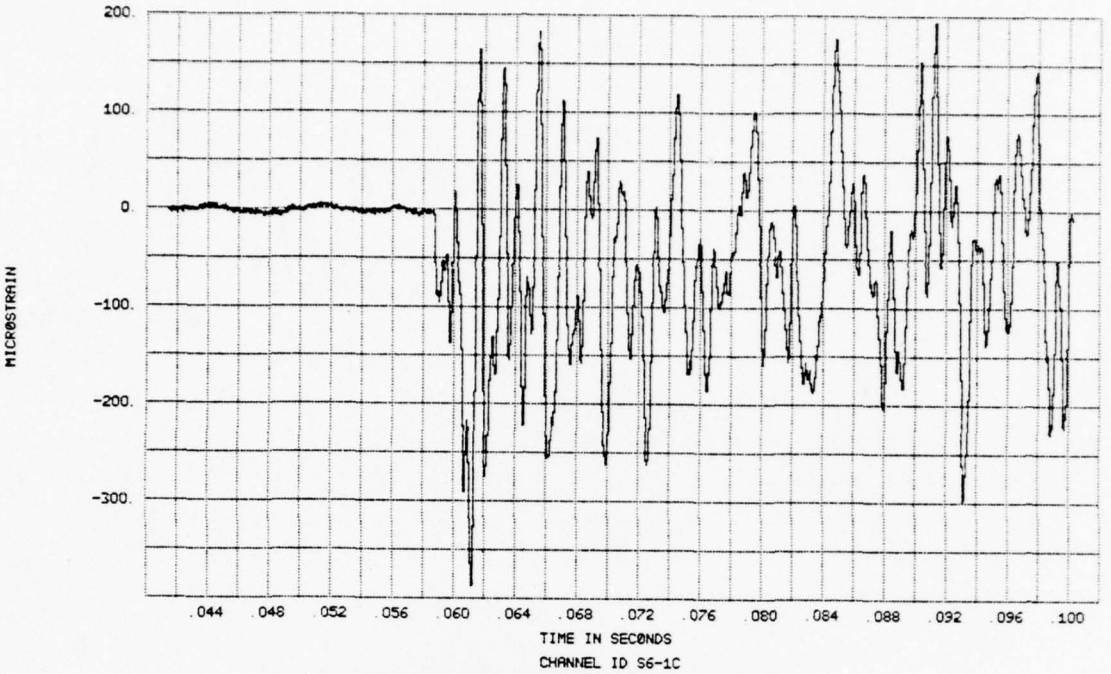


FIGURE 6-47 , SPECIMEN NO. 6 , SHOT NO. 3 , STRAIN TIME HISTORY

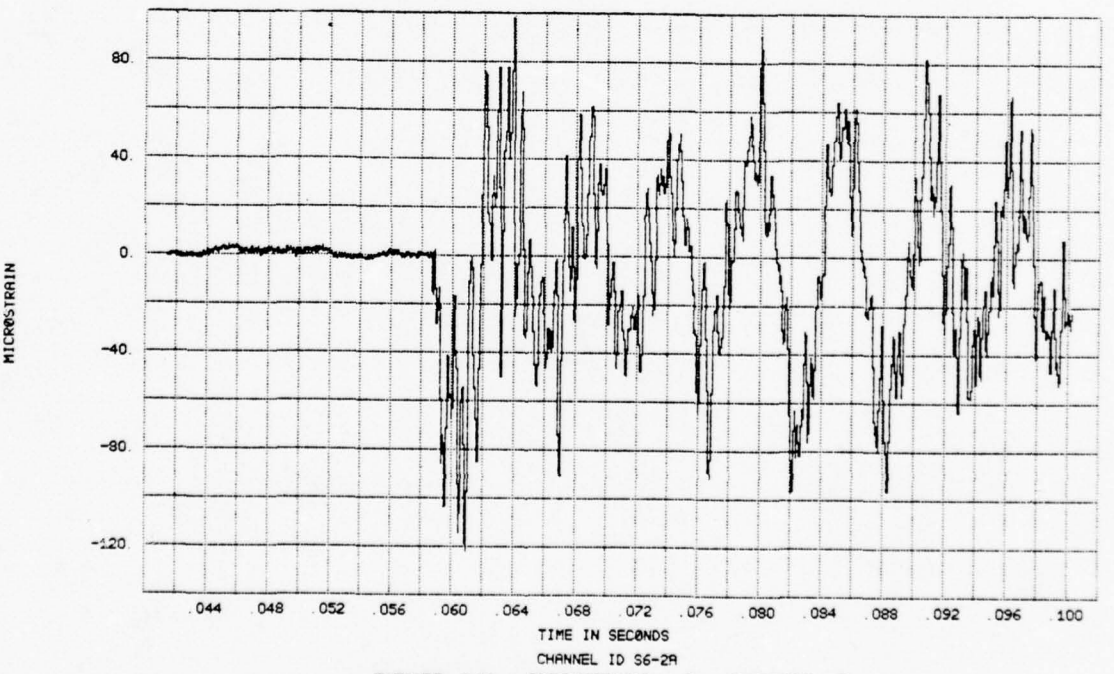


FIGURE 6-48 , SPECIMEN NO. 6 , SHOT NO. 3 , STRAIN TIME HISTORY

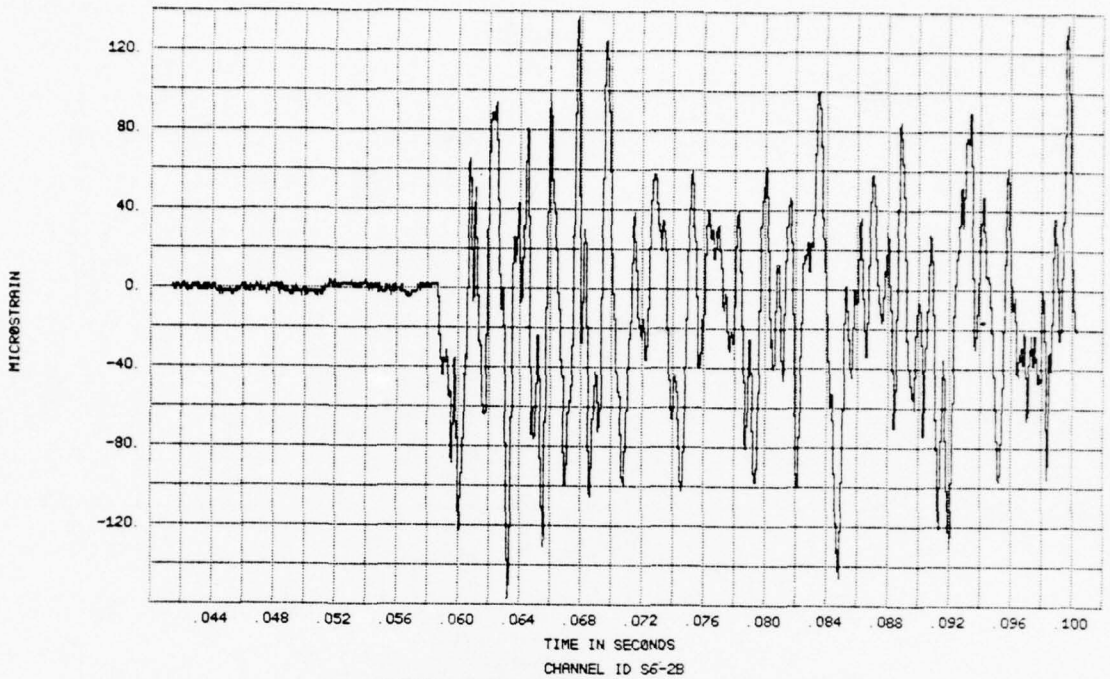


FIGURE 6-49 , SPECIMEN NO. 6 , SHOT NO. 3 , STRAIN TIME HISTORY

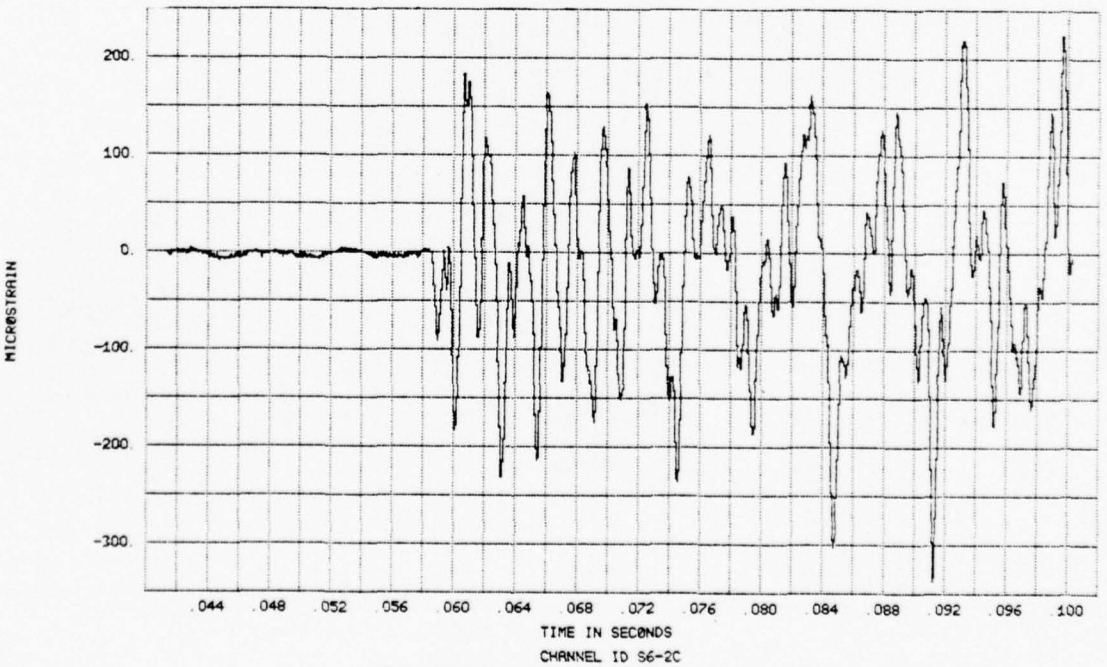


FIGURE 6-50 , SPECIMEN NO. 6 , SHOT NO. 3 , STRAIN TIME HISTORY

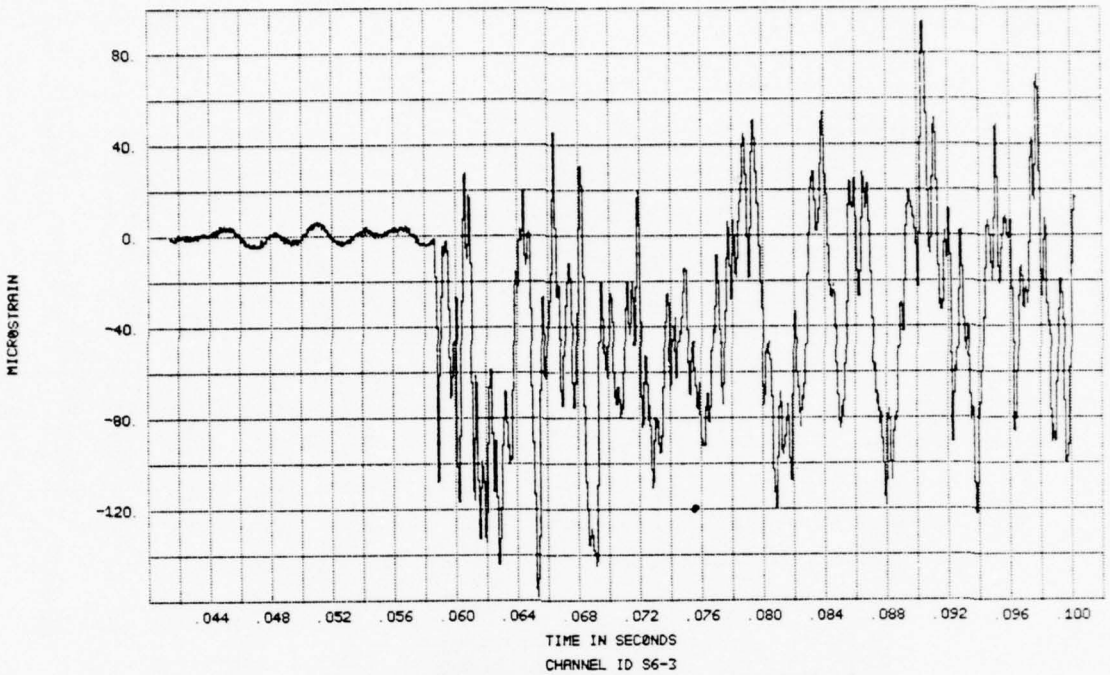


FIGURE 6-51 , SPECIMEN NO. 6 , SHOT NO. 3 , STRAIN TIME HISTORY

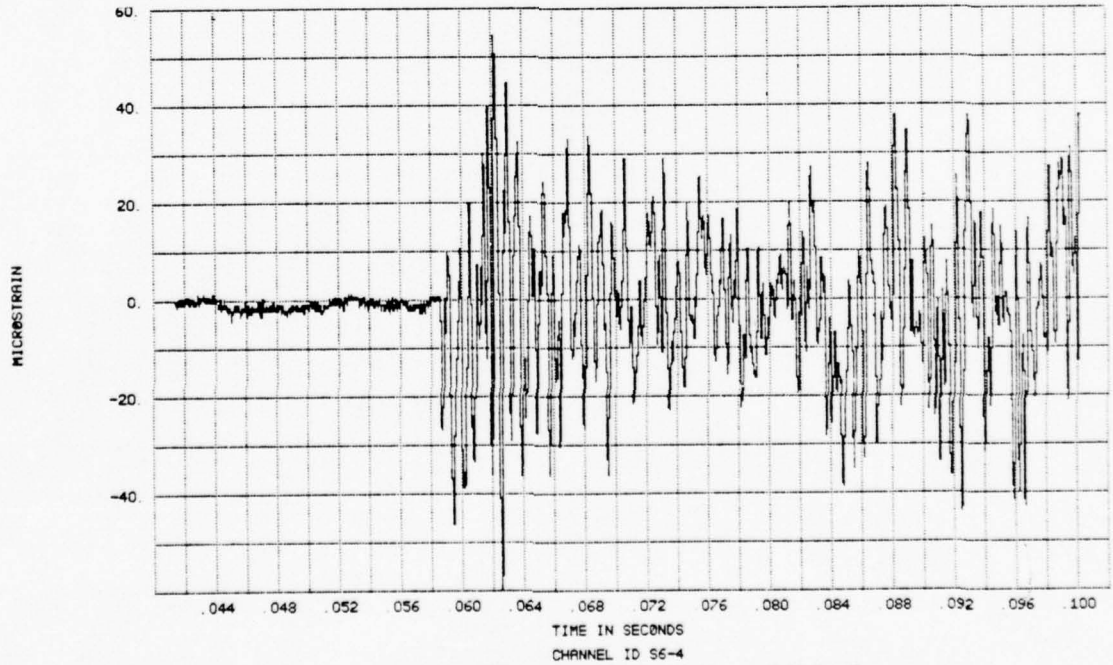


FIGURE 6-52 , SPECIMEN NO. 6 , SHOT NO. 3 , STRAIN TIME HISTORY

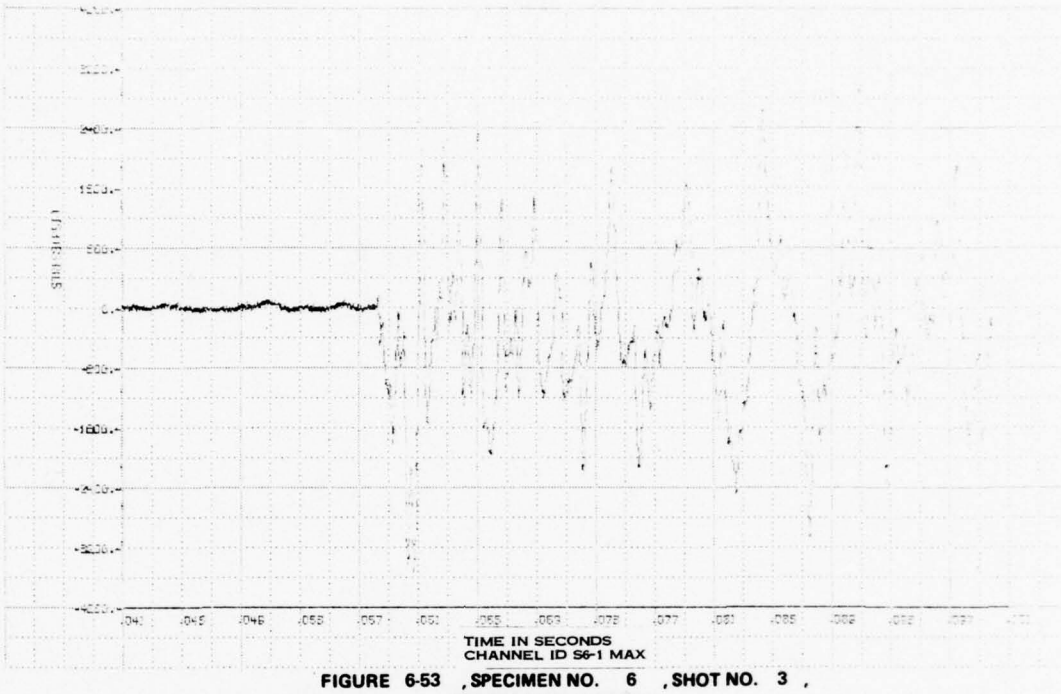


FIGURE 6-53 , SPECIMEN NO. 6 , SHOT NO. 3 ,
STRESS TIME HISTORY

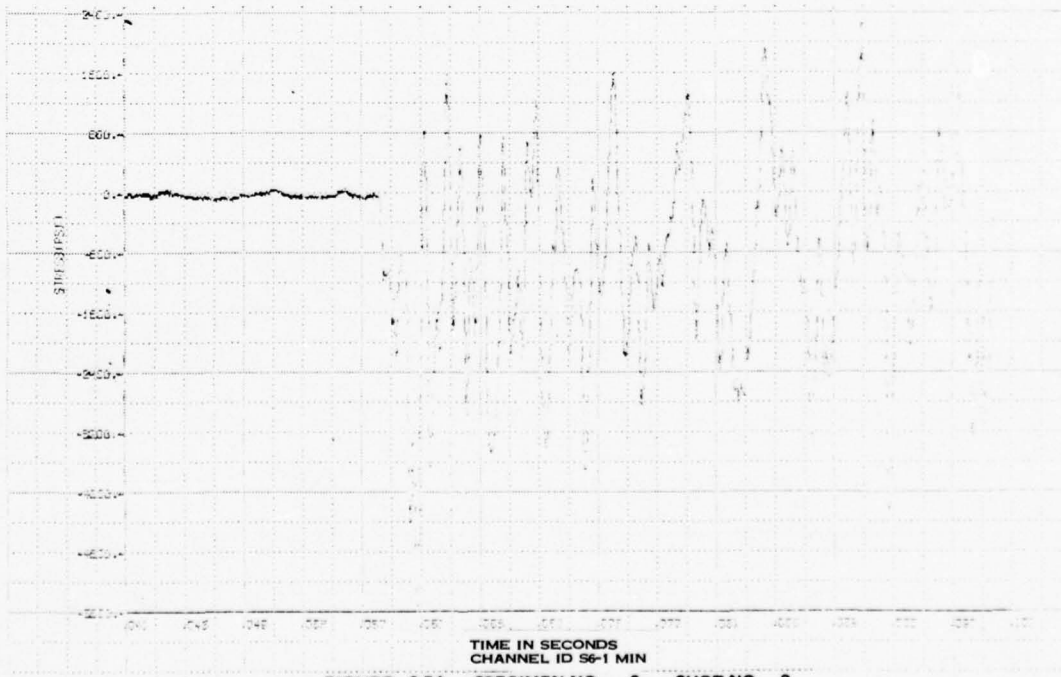


FIGURE 6-54 , SPECIMEN NO. 6 , SHOT NO. 3 ,
STRESS TIME HISTORY

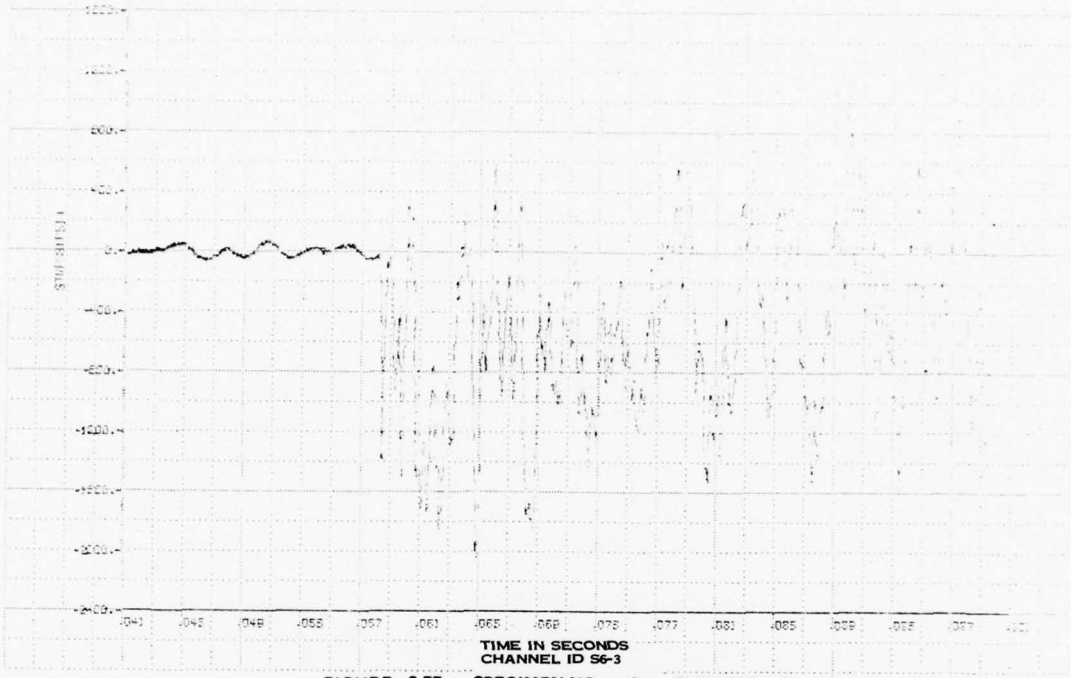


FIGURE 6-55 , SPECIMEN NO. 6 , SHOT NO. 3 ,
STRESS TIME HISTORY

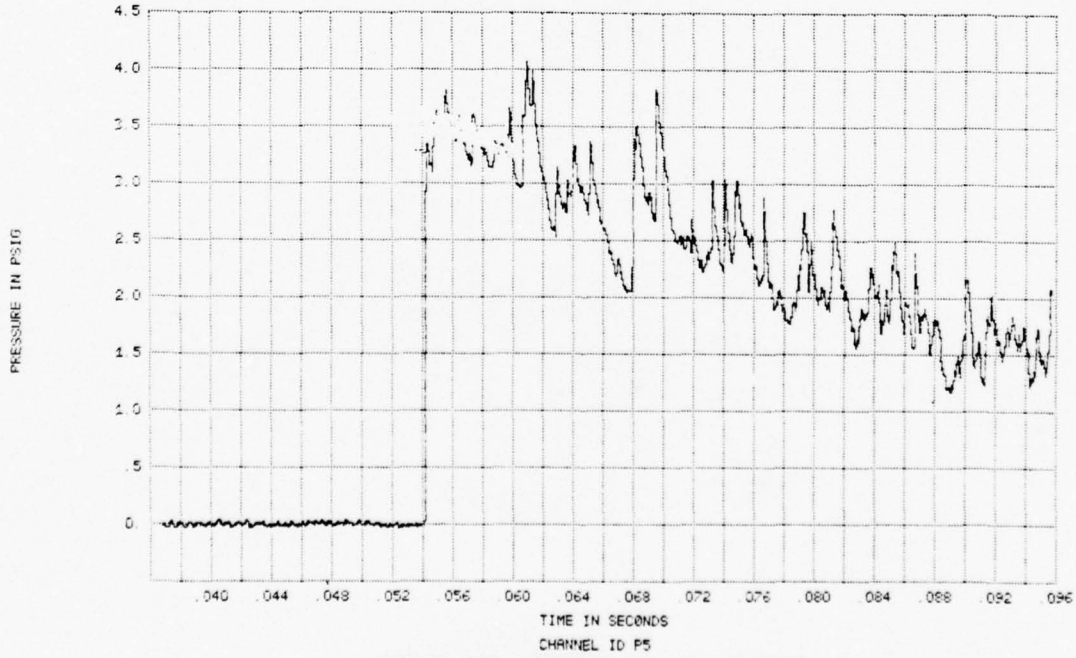


FIGURE 6-56 , SPECIMEN NO. 6 , SHOT NO. 4 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

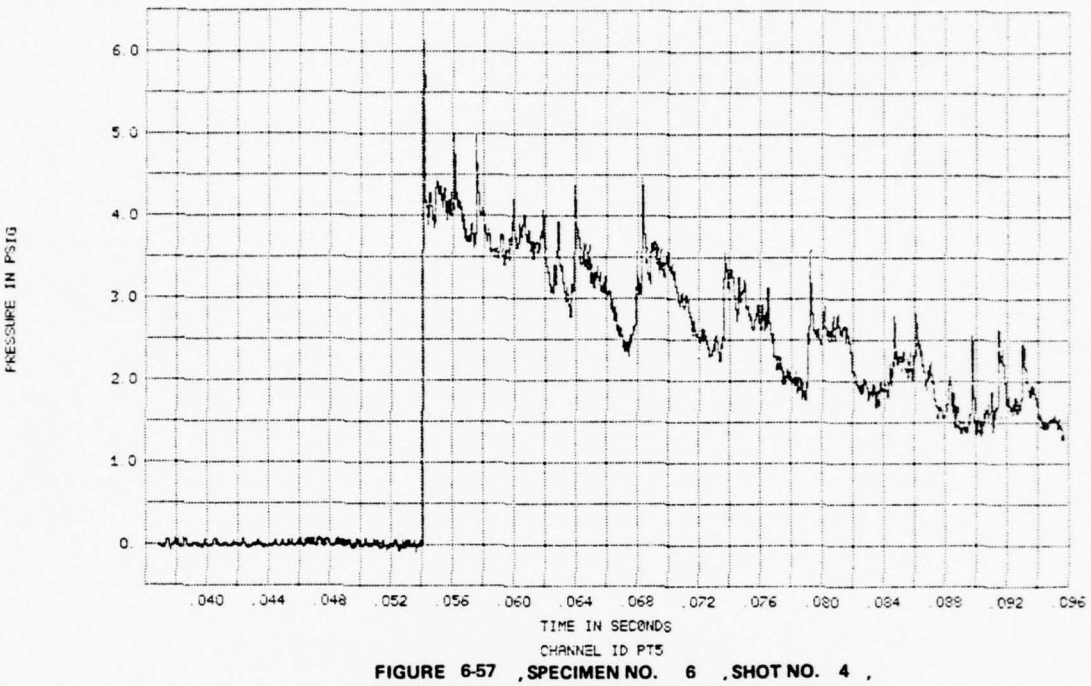


FIGURE 6-57 , SPECIMEN NO. 6 , SHOT NO. 4 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

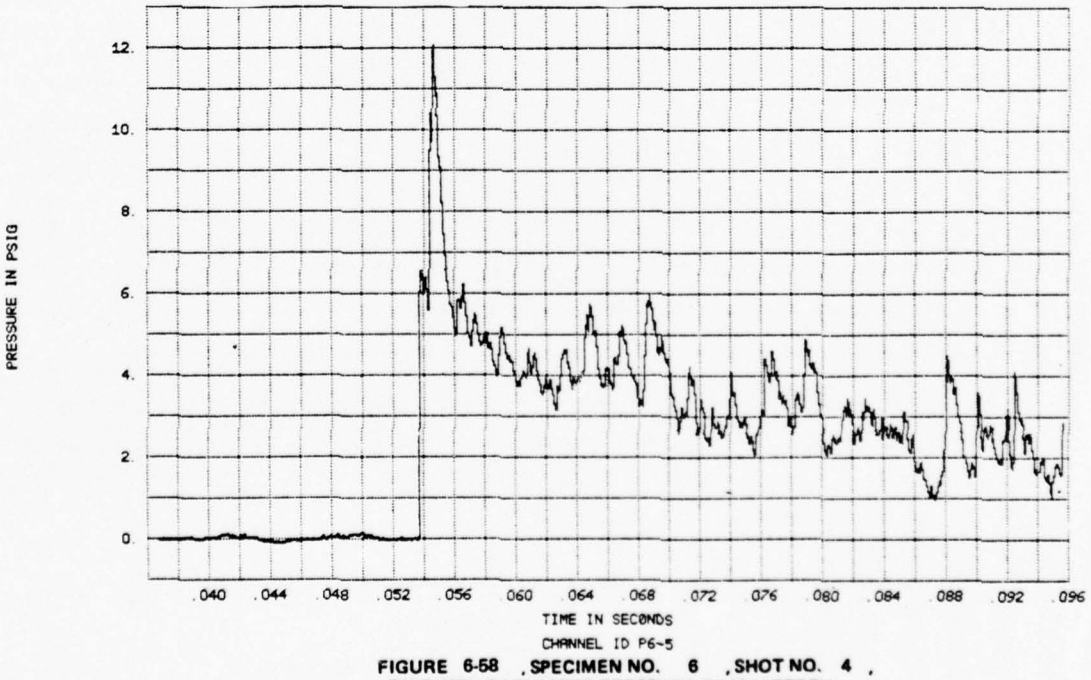


FIGURE 6-58 , SPECIMEN NO. 6 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

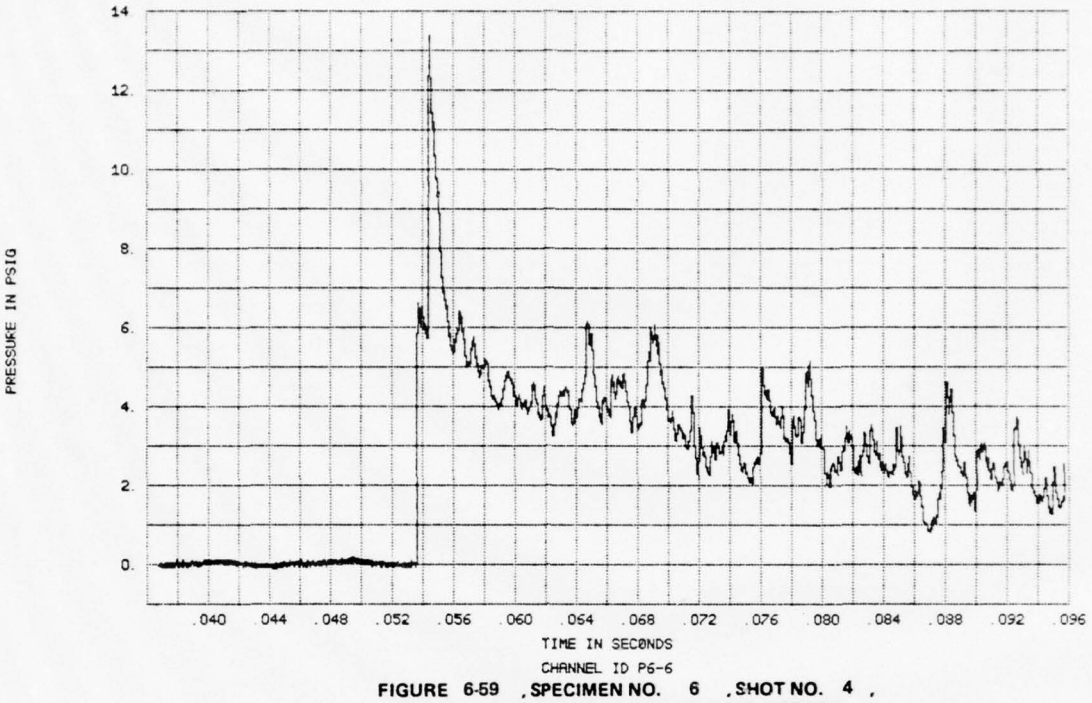


FIGURE 6-59 , SPECIMEN NO. 6 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

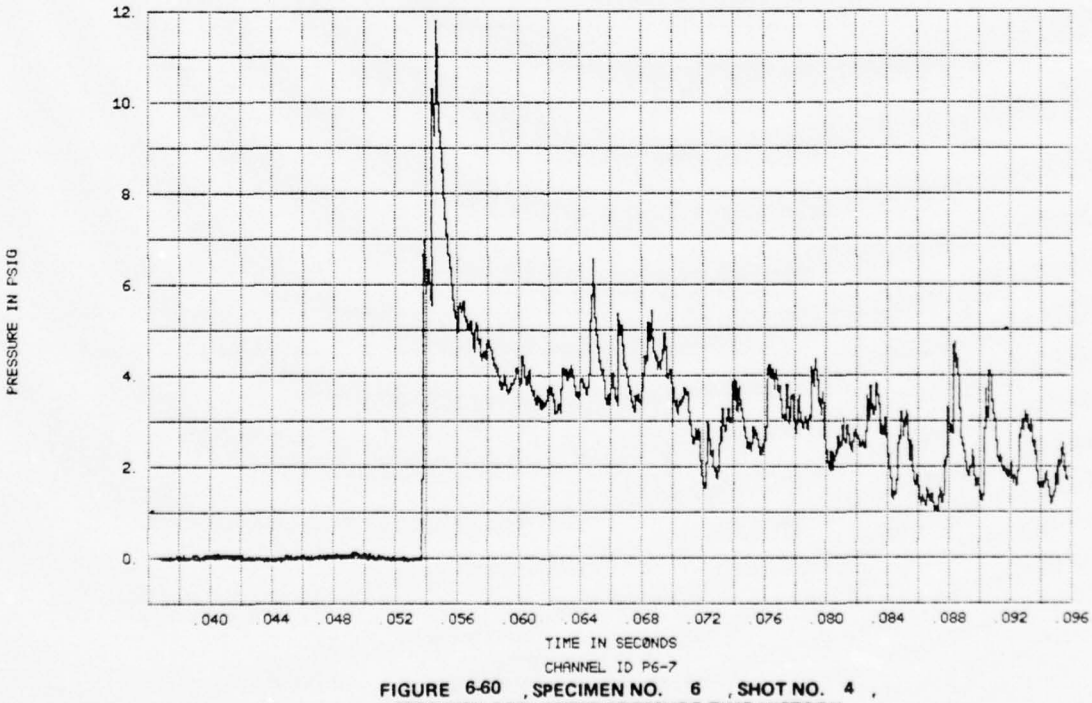


FIGURE 6-60 , SPECIMEN NO. 6 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

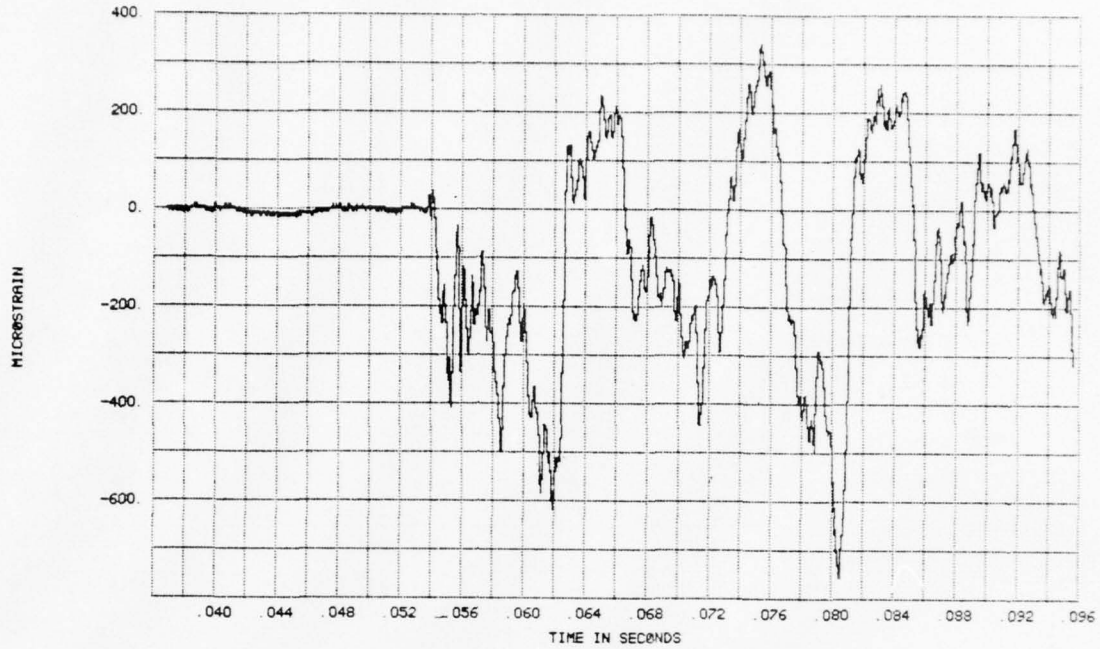


FIGURE 6-61 , SPECIMEN NO. 6 , SHOT NO. 4 ,
STRAIN TIME HISTORY

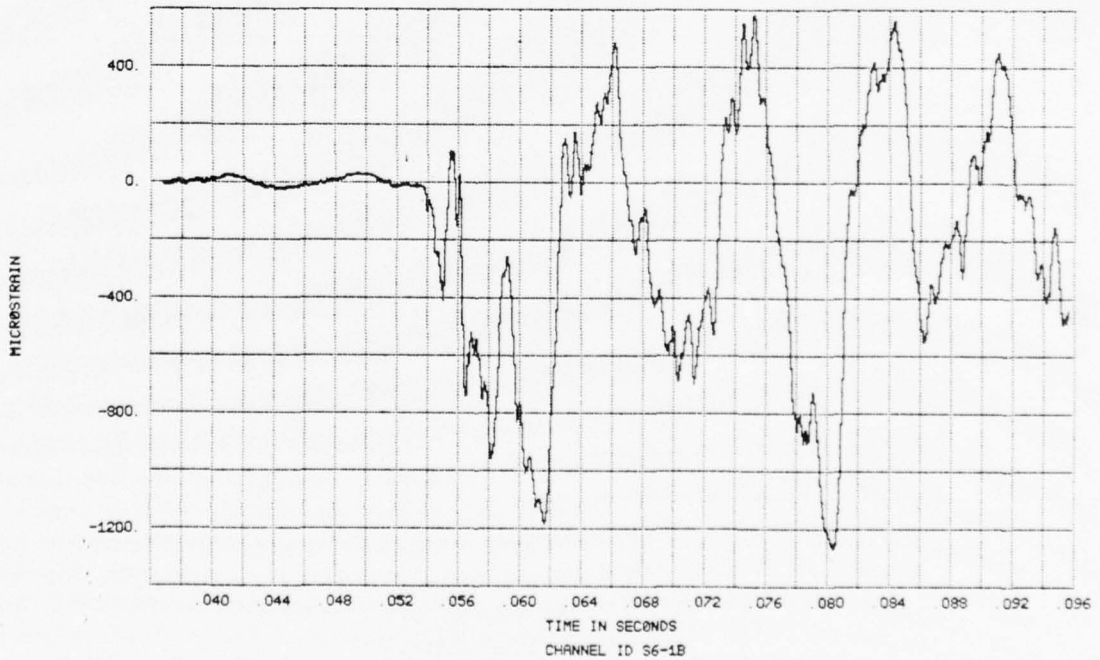


FIGURE 6-62 , SPECIMEN NO. 6 , SHOT NO. 4 ,
STRAIN TIME HISTORY

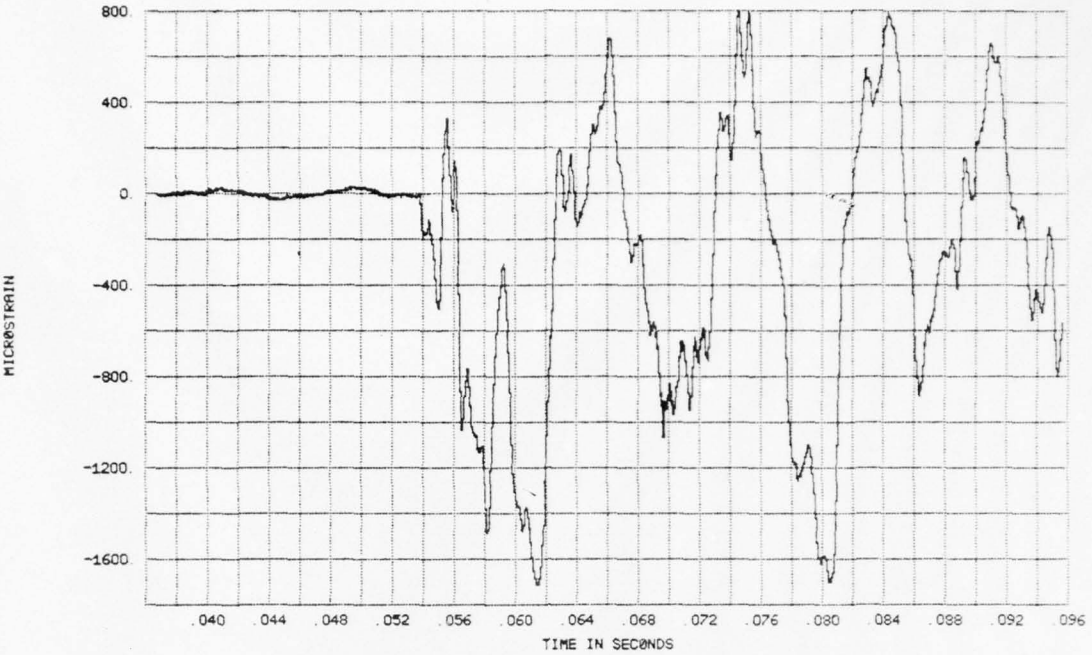


FIGURE 6-63 , SPECIMEN NO. 6 , SHOT NO. 4 ,
STRAIN TIME HISTORY

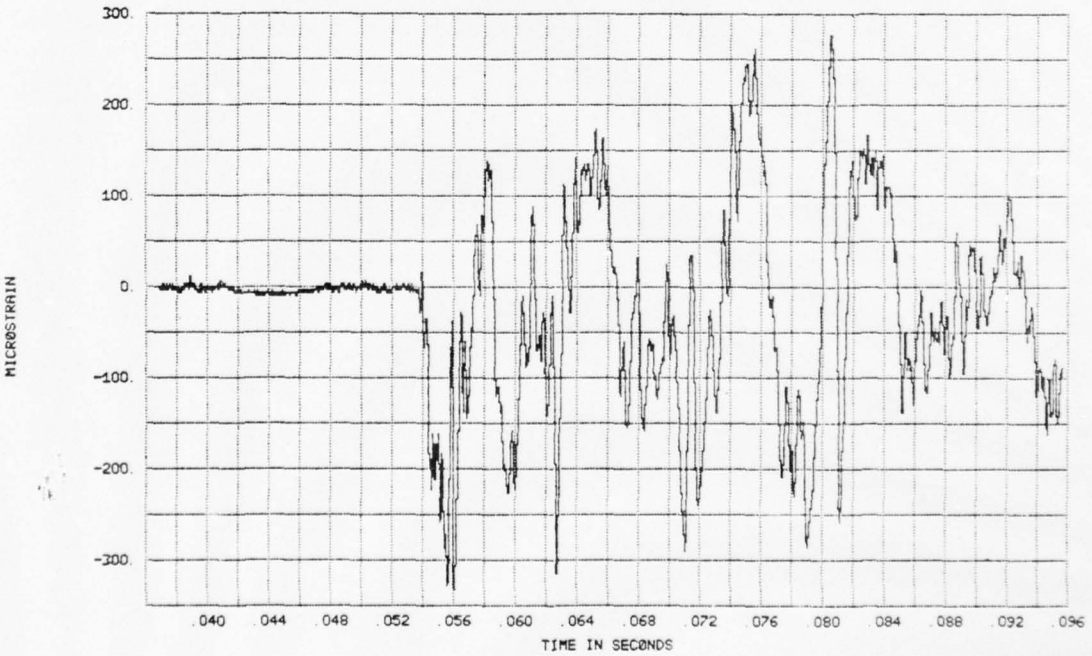


FIGURE 6-64 , SPECIMEN NO. 6 , SHOT NO. 4 ,
STRAIN TIME HISTORY

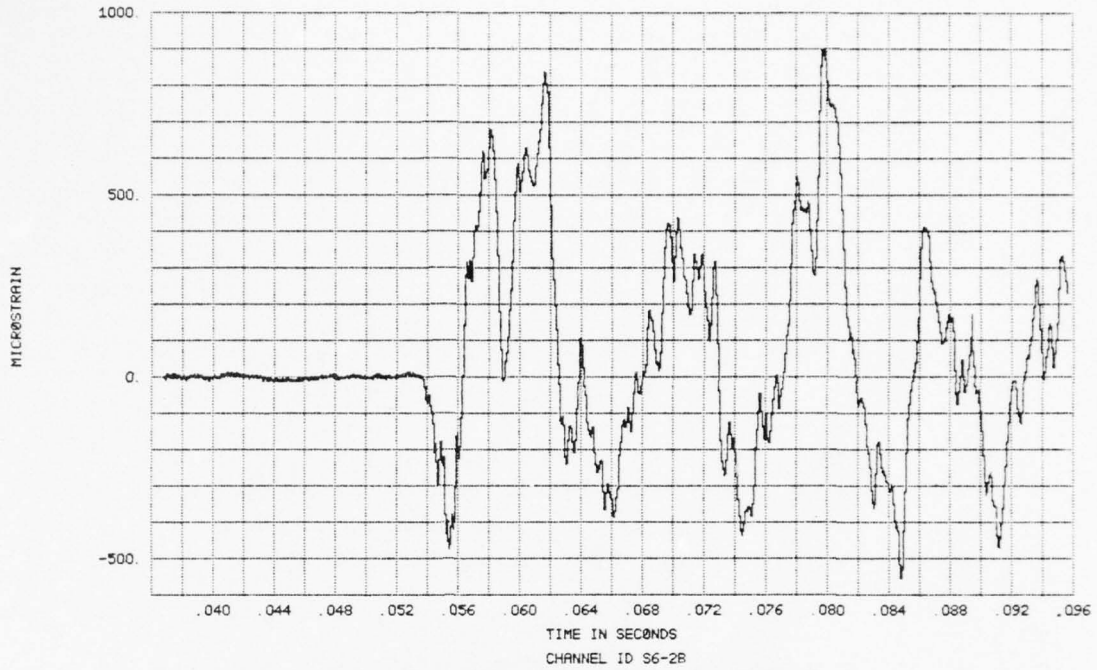


FIGURE 6-65 , SPECIMEN NO. 6 , SHOT NO. 4 ,
STRAIN TIME HISTORY

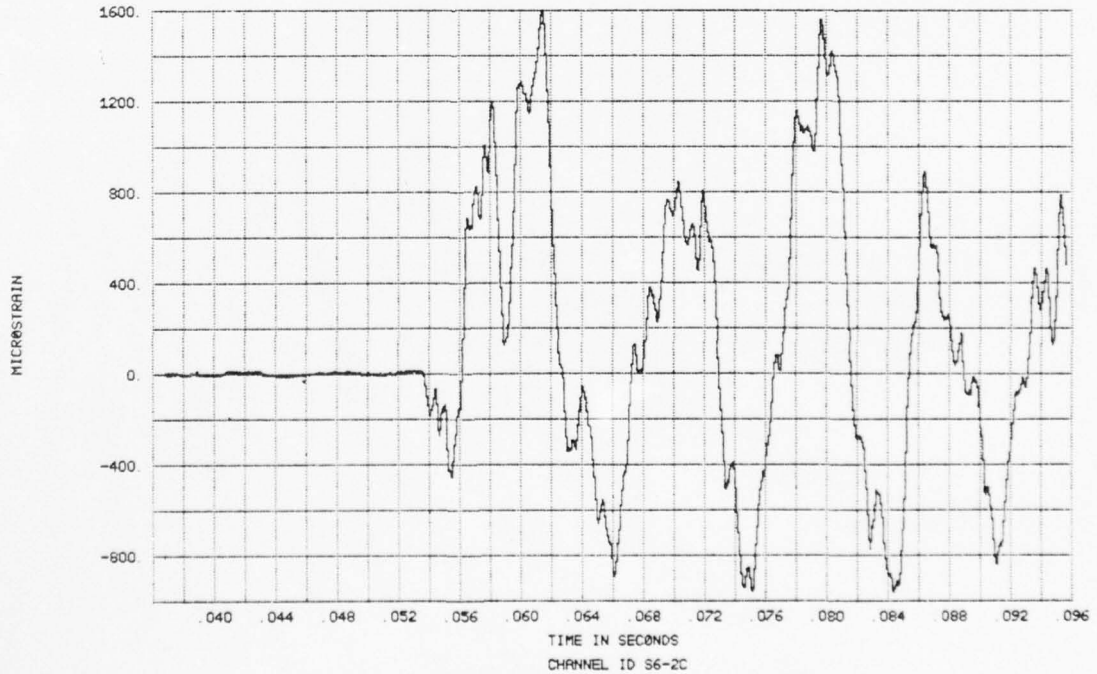


FIGURE 6-66 , SPECIMEN NO. 6 , SHOT NO. 4 ,
STRAIN TIME HISTORY

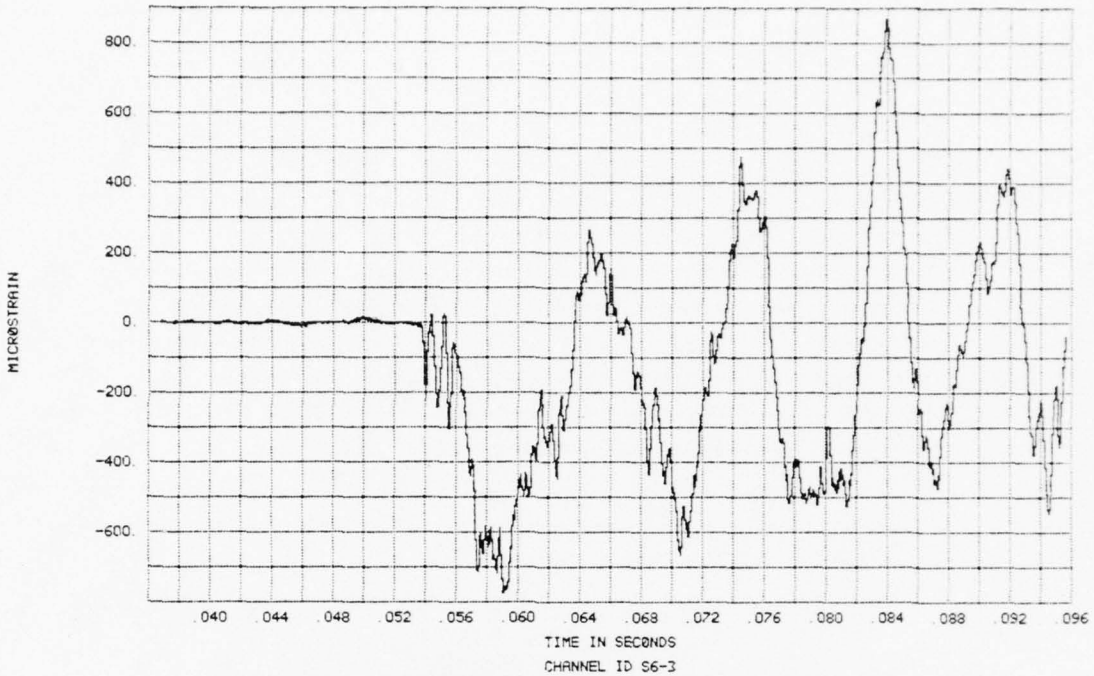


FIGURE 6-67 , SPECIMEN NO. 6 , SHOT NO. 4 ,
STRAIN TIME HISTORY

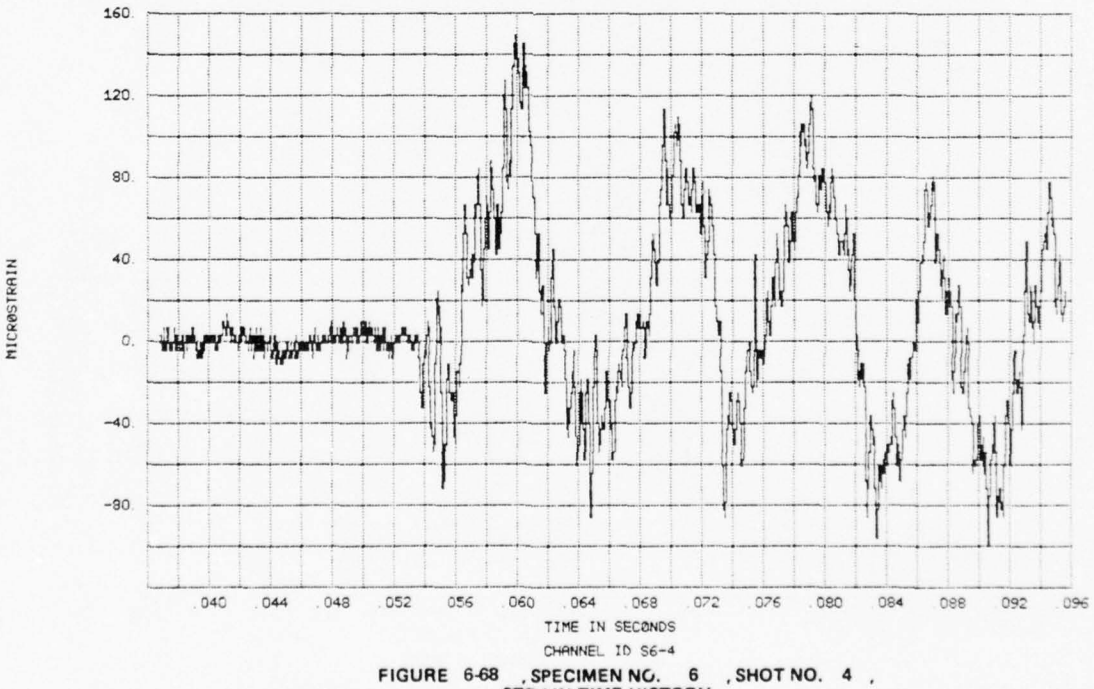


FIGURE 6-68 , SPECIMEN NO. 6 , SHOT NO. 4 ,
STRAIN TIME HISTORY

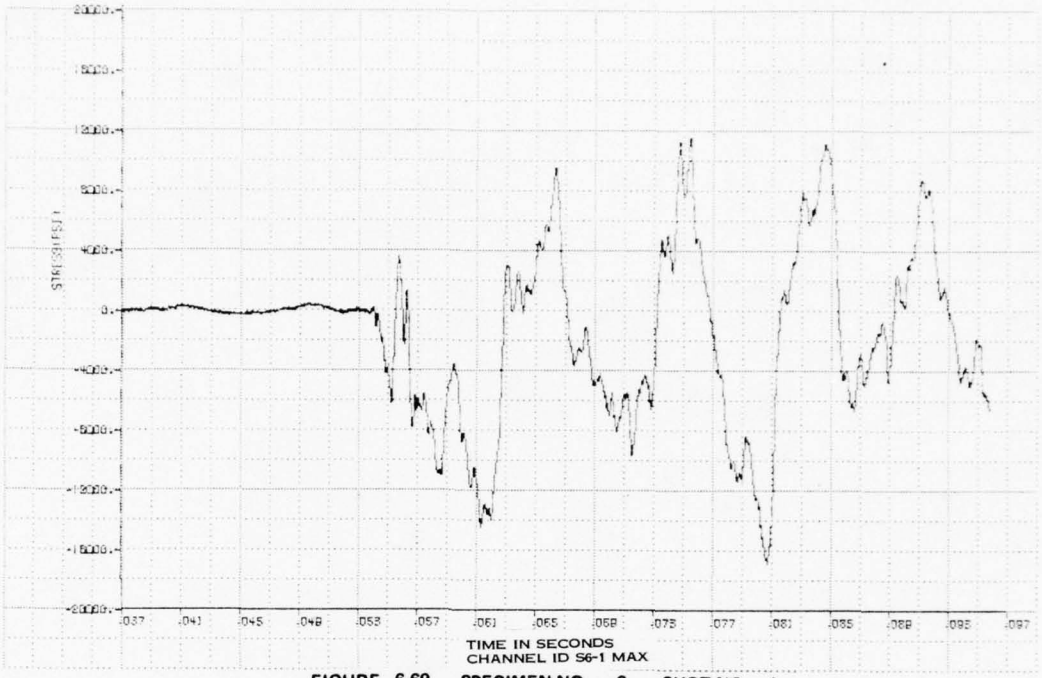


FIGURE 6-69 , SPECIMEN NO. 6 , SHOT NO. 4 ,
STRESS TIME HISTORY

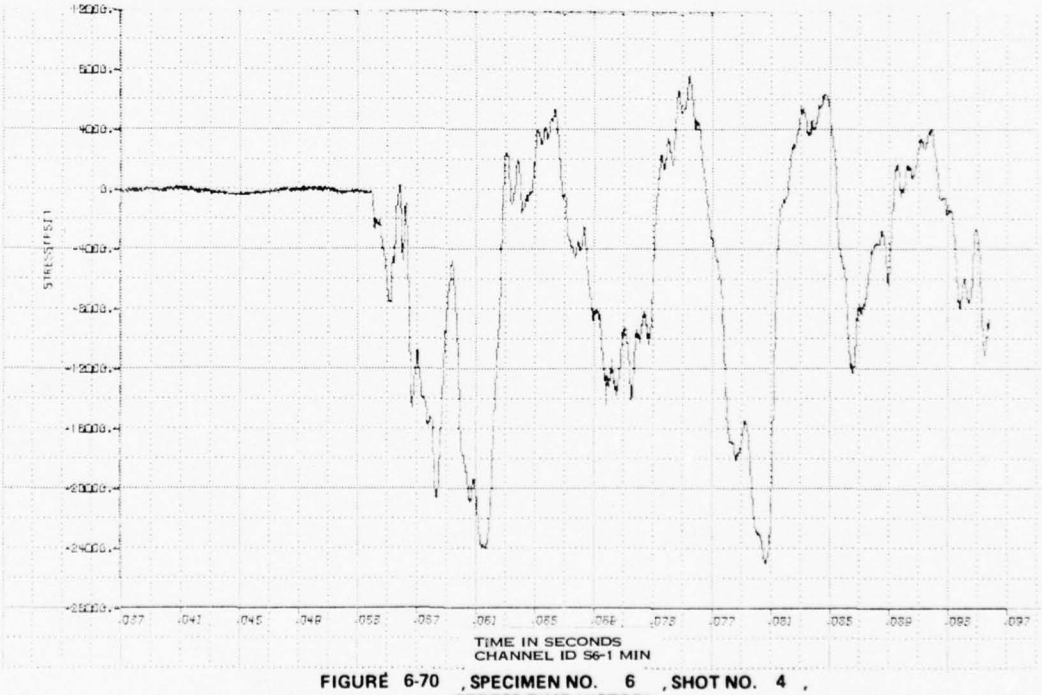


FIGURE 6-70 , SPECIMEN NO. 6 , SHOT NO. 4 ,
STRESS TIME HISTORY

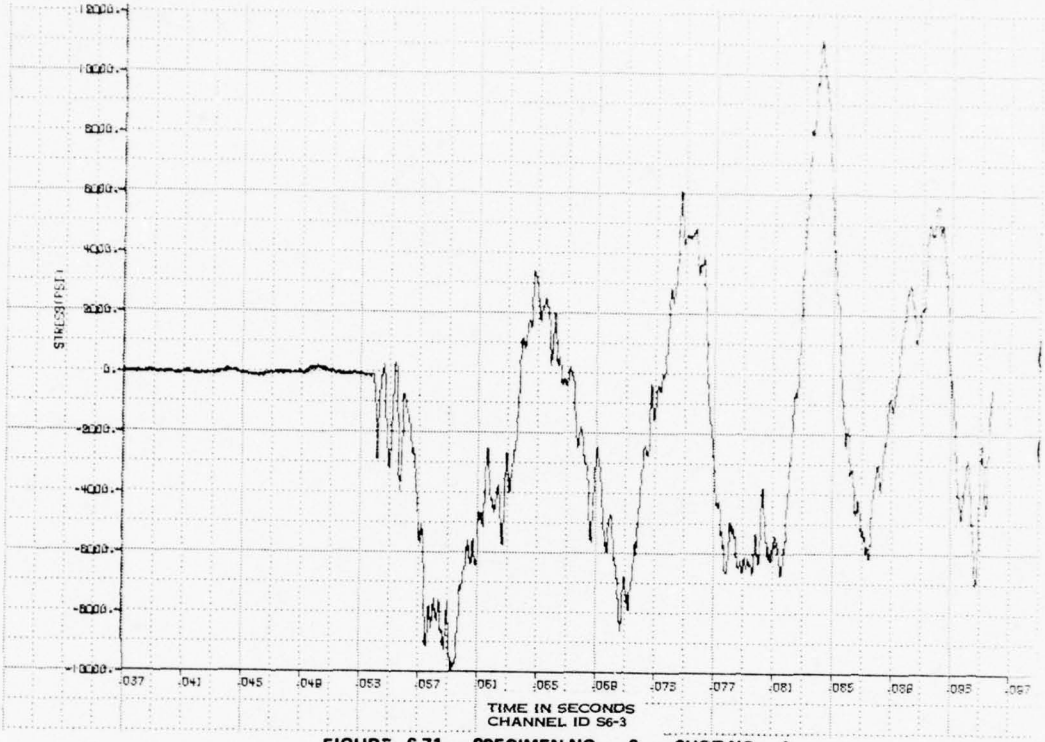


FIGURE 6-71 , SPECIMEN NO. 6 , SHOT NO. 4 ,
STRESS TIME HISTORY

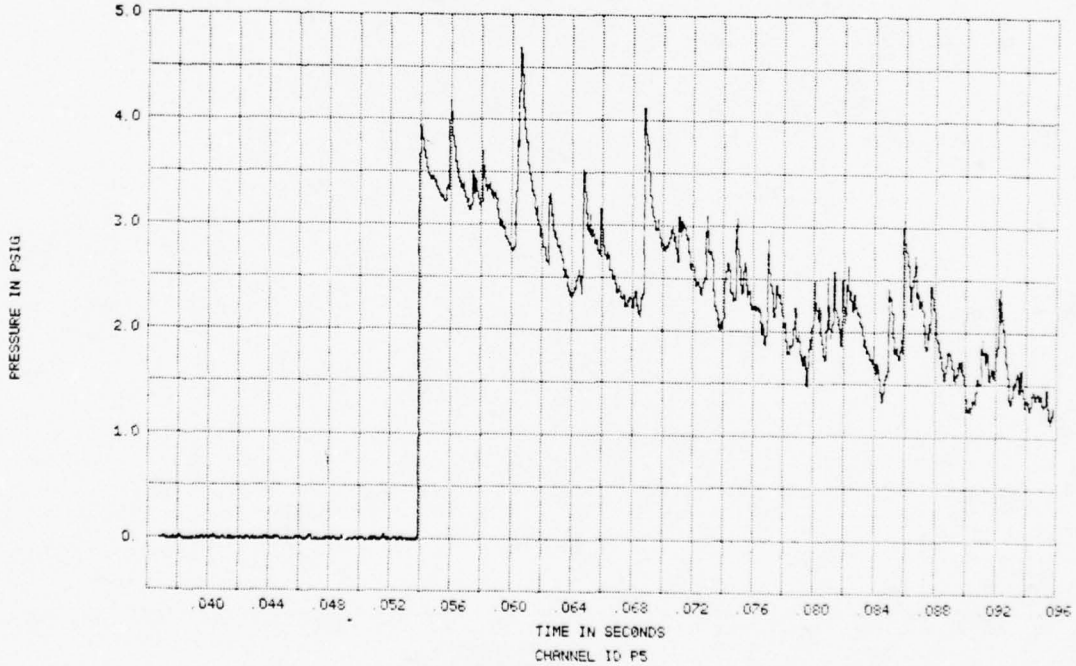


FIGURE 6-72 , SPECIMEN NO. 6 , SHOT NO. 5 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

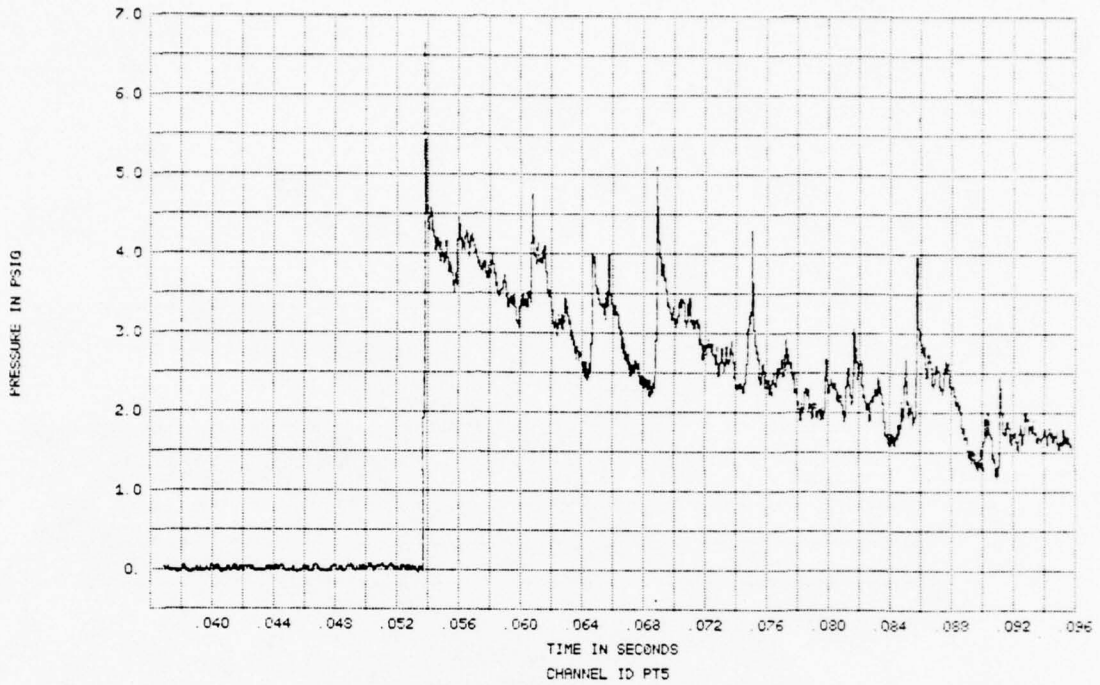


FIGURE 6-73 , SPECIMEN NO. 6 , SHOT NO. 5 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

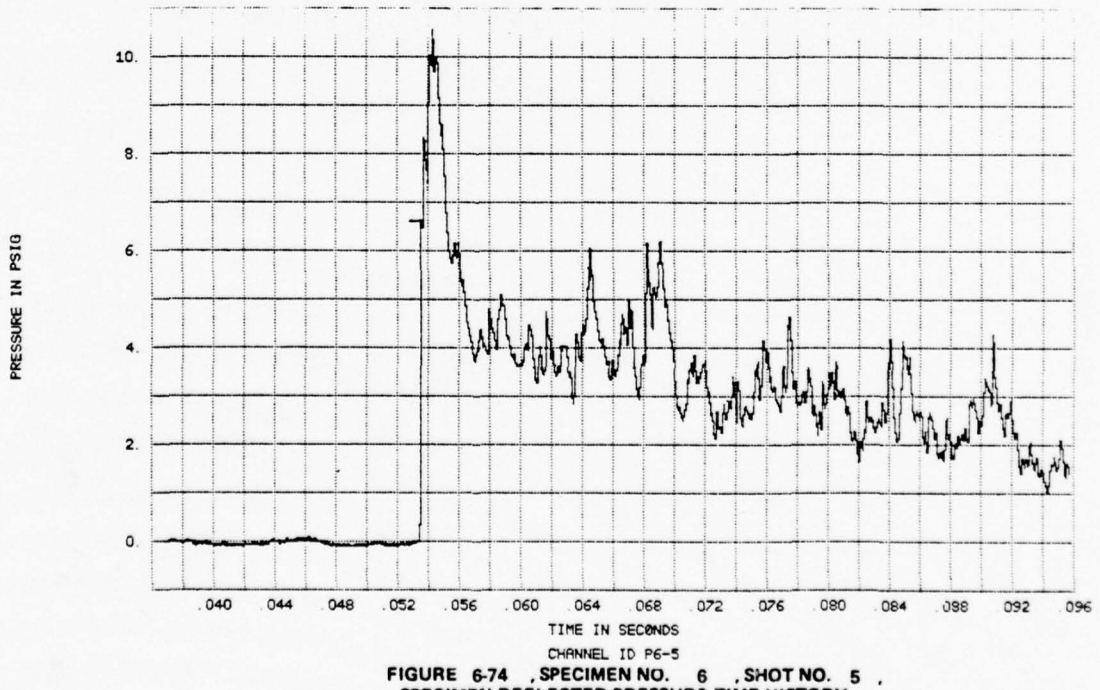


FIGURE 6-74 , SPECIMEN NO. 6 , SHOT NO. 5 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

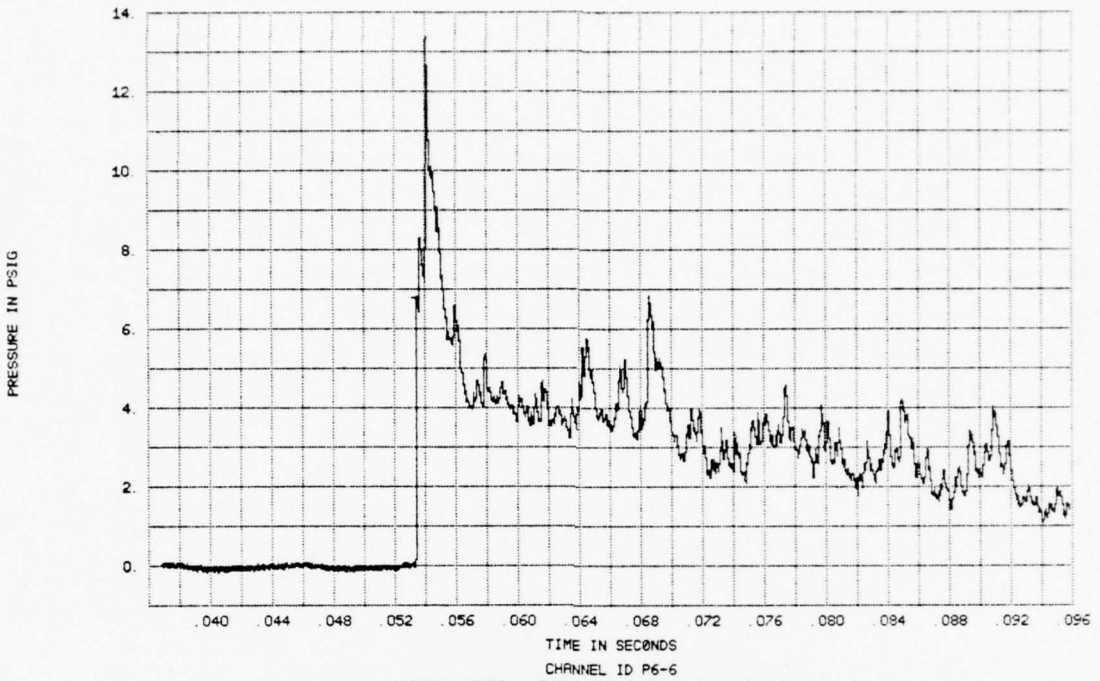


FIGURE 6-75 , SPECIMEN NO. 6 , SHOT NO. 5 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

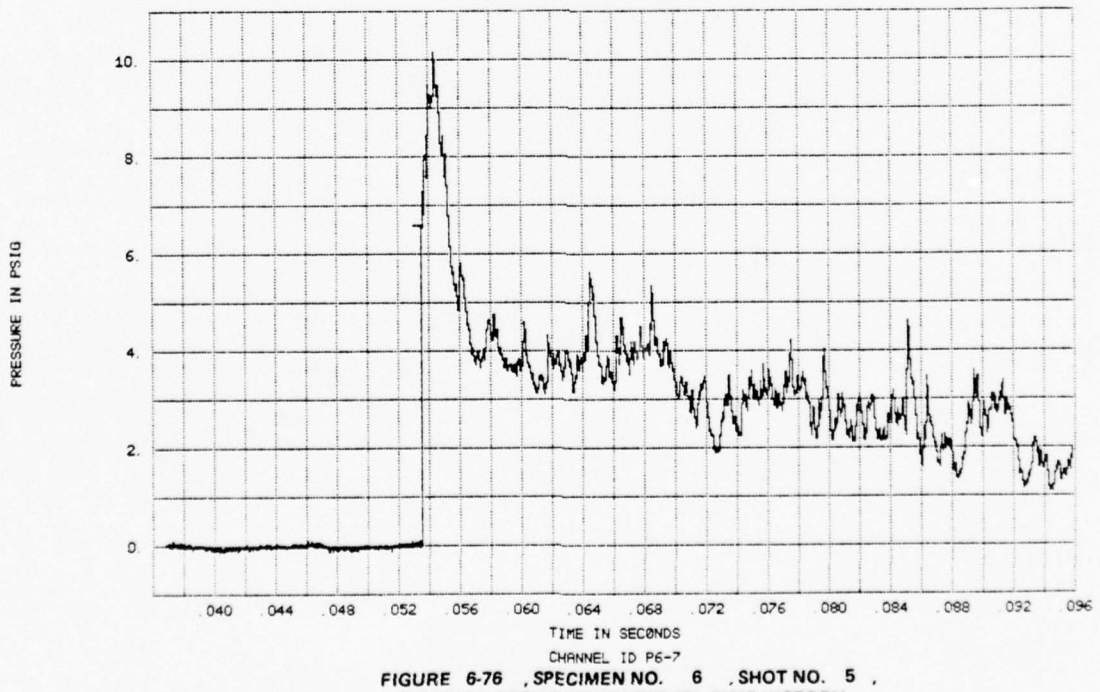


FIGURE 6-76 , SPECIMEN NO. 6 , SHOT NO. 5 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

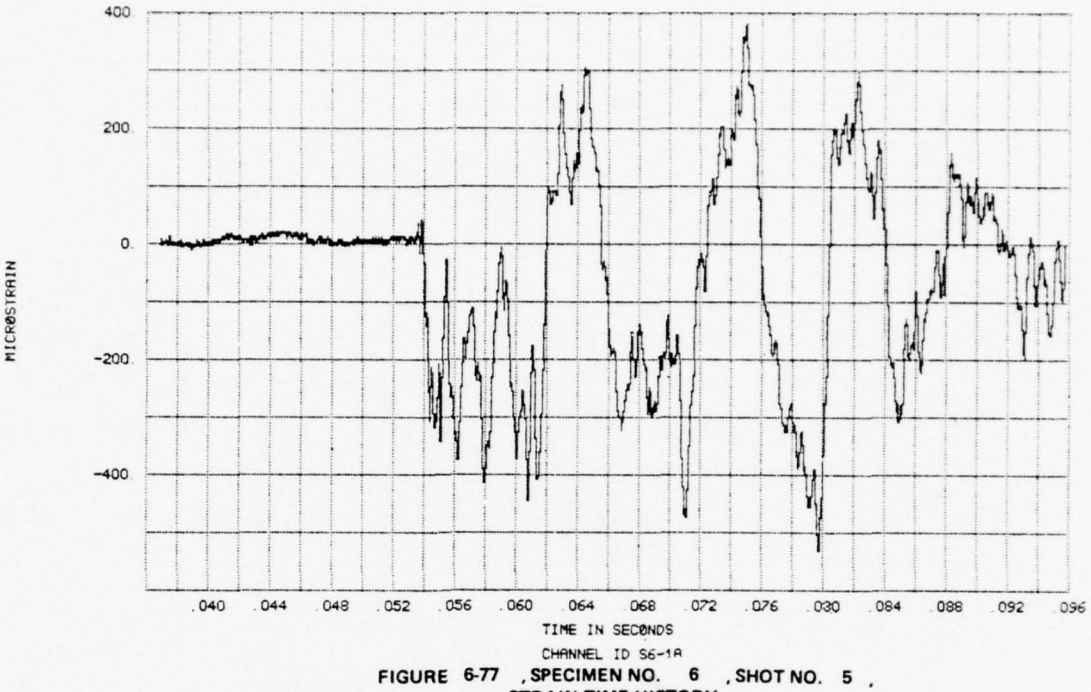


FIGURE 6-77 , SPECIMEN NO. 6 , SHOT NO. 5 ,
STRAIN TIME HISTORY

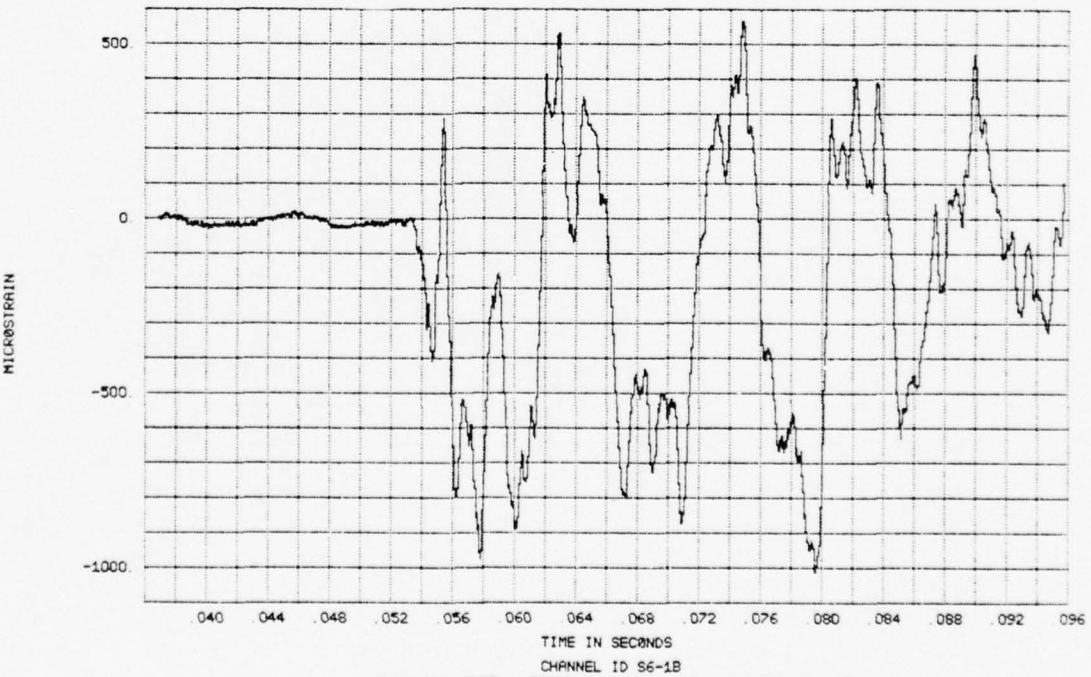


FIGURE 6-78 , SPECIMEN NO. 6 , SHOT NO. 5 ,
STRAIN TIME HISTORY

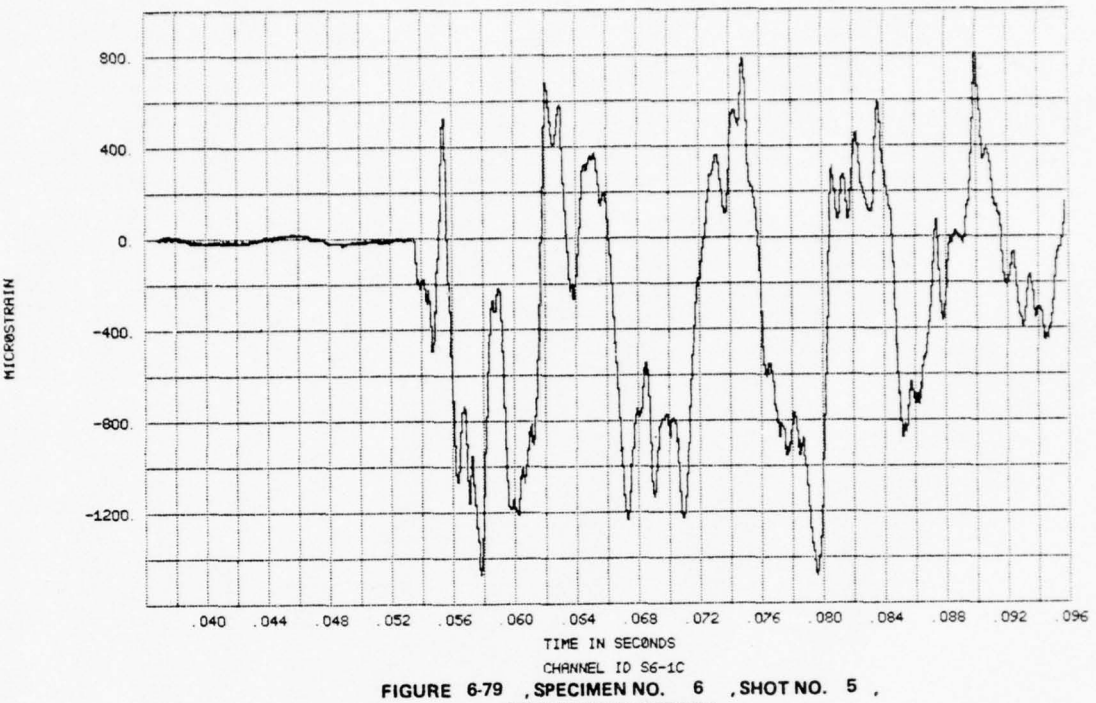


FIGURE 6-79 , SPECIMEN NO. 6 , SHOT NO. 5 , STRAIN TIME HISTORY

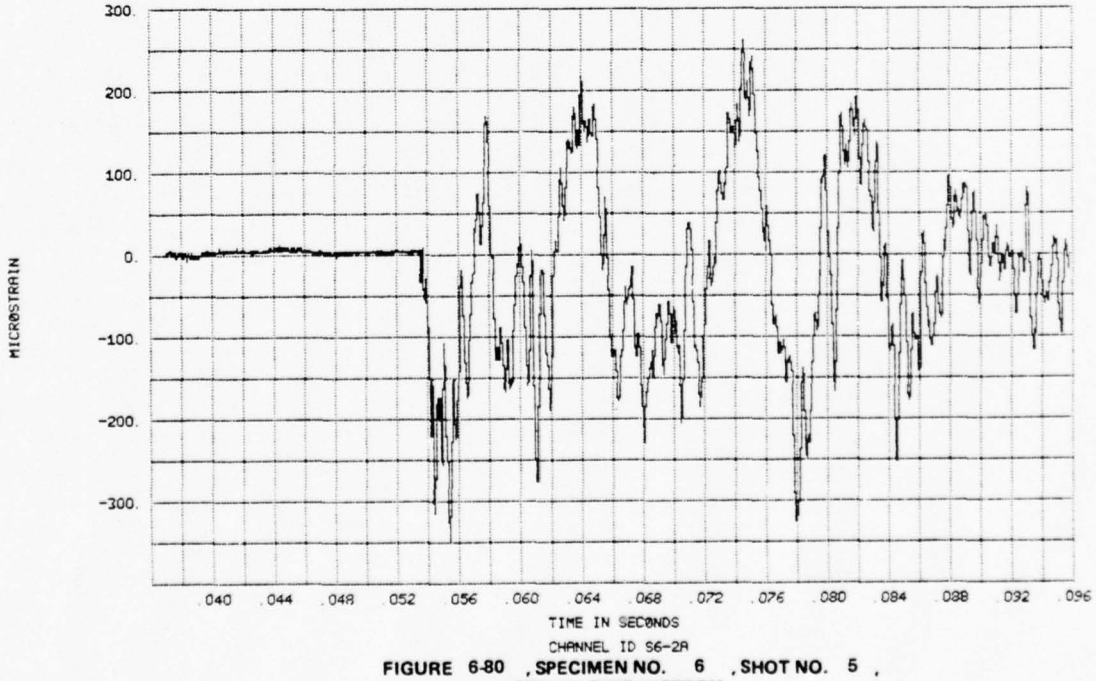


FIGURE 6-80 , SPECIMEN NO. 6 , SHOT NO. 5 , STRAIN TIME HISTORY

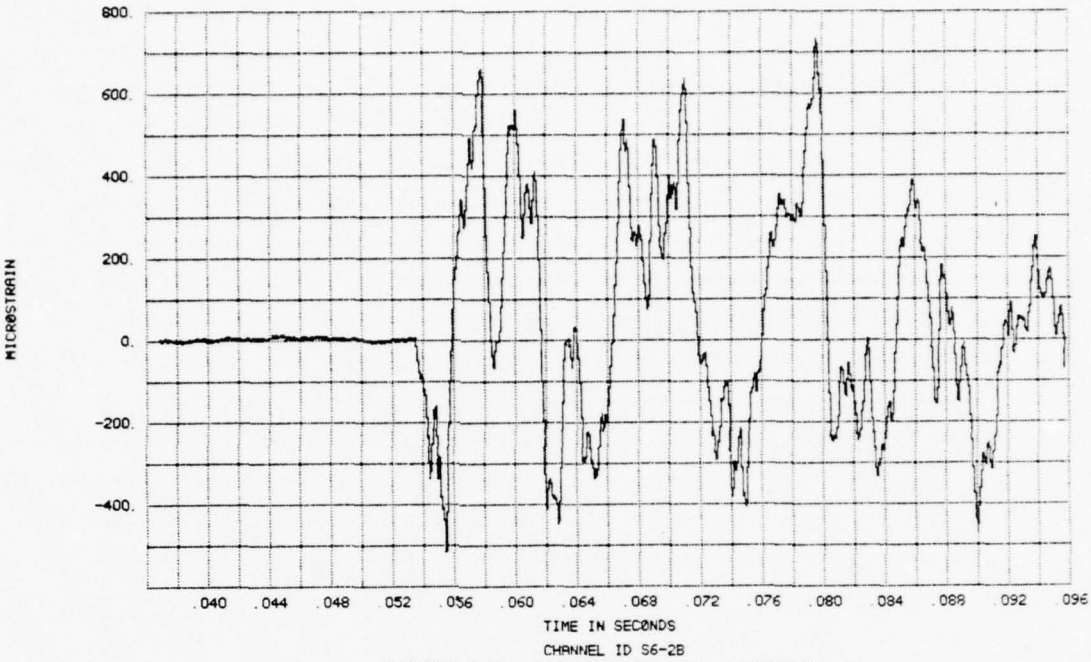


FIGURE 6-81 , SPECIMEN NO. 6 , SHOT NO. 5 , STRAIN TIME HISTORY

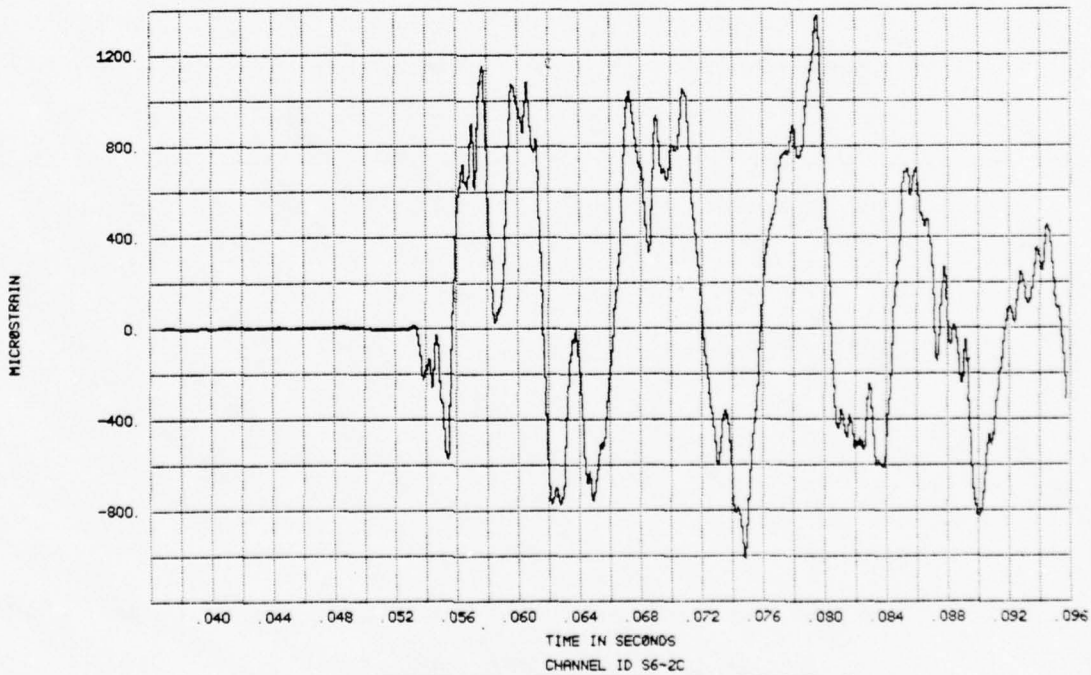


FIGURE 6-82 , SPECIMEN NO. 6 , SHOT NO. 5 , STRAIN TIME HISTORY

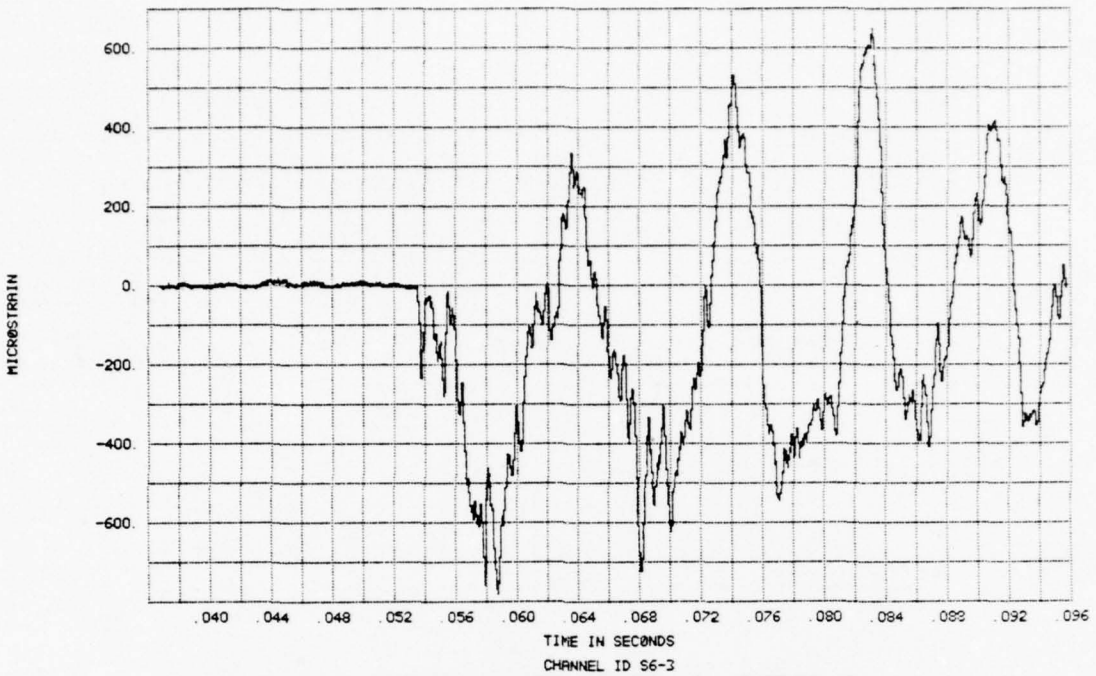


FIGURE 6-83 , SPECIMEN NO. 6 , SHOT NO. 5 , STRAIN TIME HISTORY

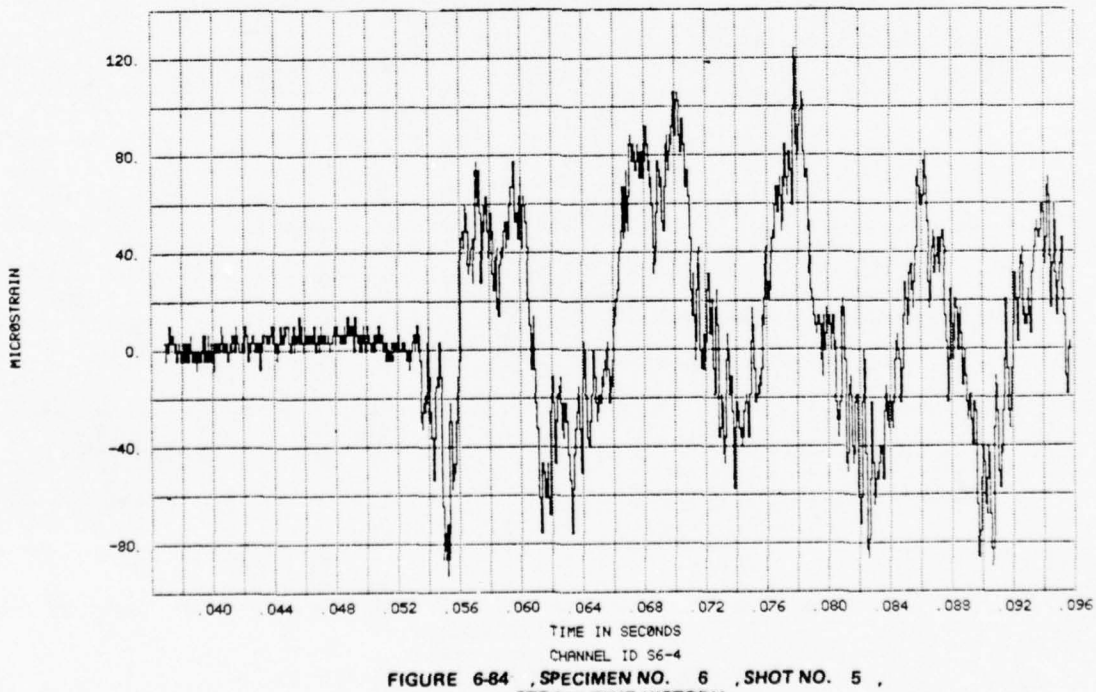


FIGURE 6-84 , SPECIMEN NO. 6 , SHOT NO. 5 , STRAIN TIME HISTORY

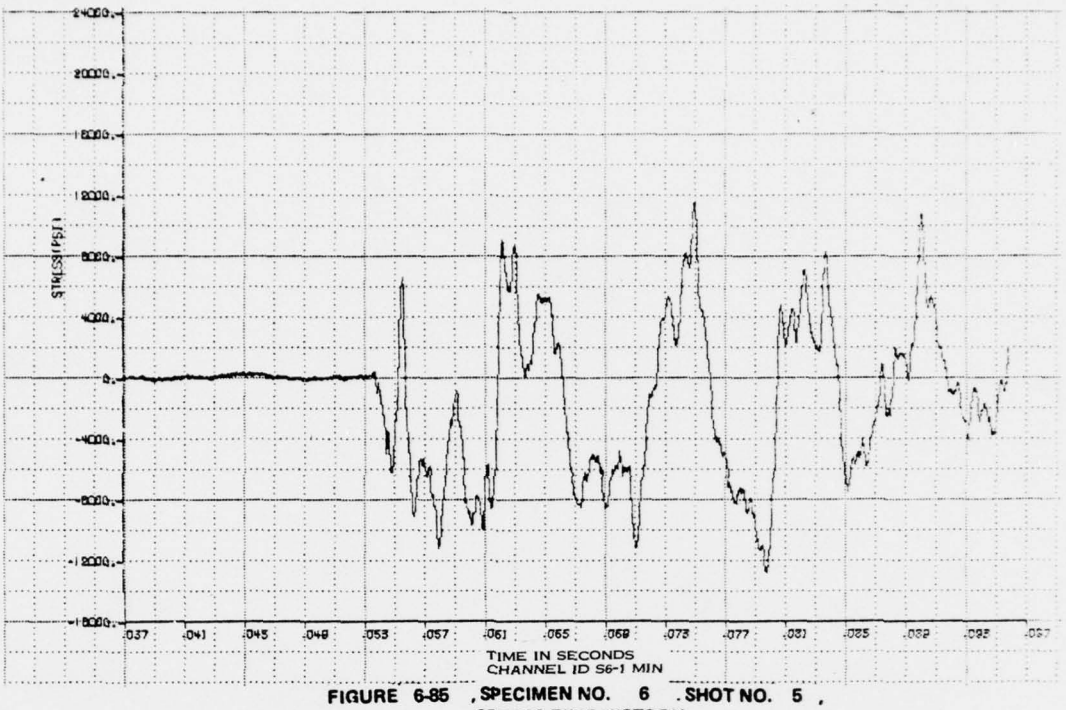


FIGURE 6-85 , SPECIMEN NO. 6 , SHOT NO. 5 ,
STRESS TIME HISTORY

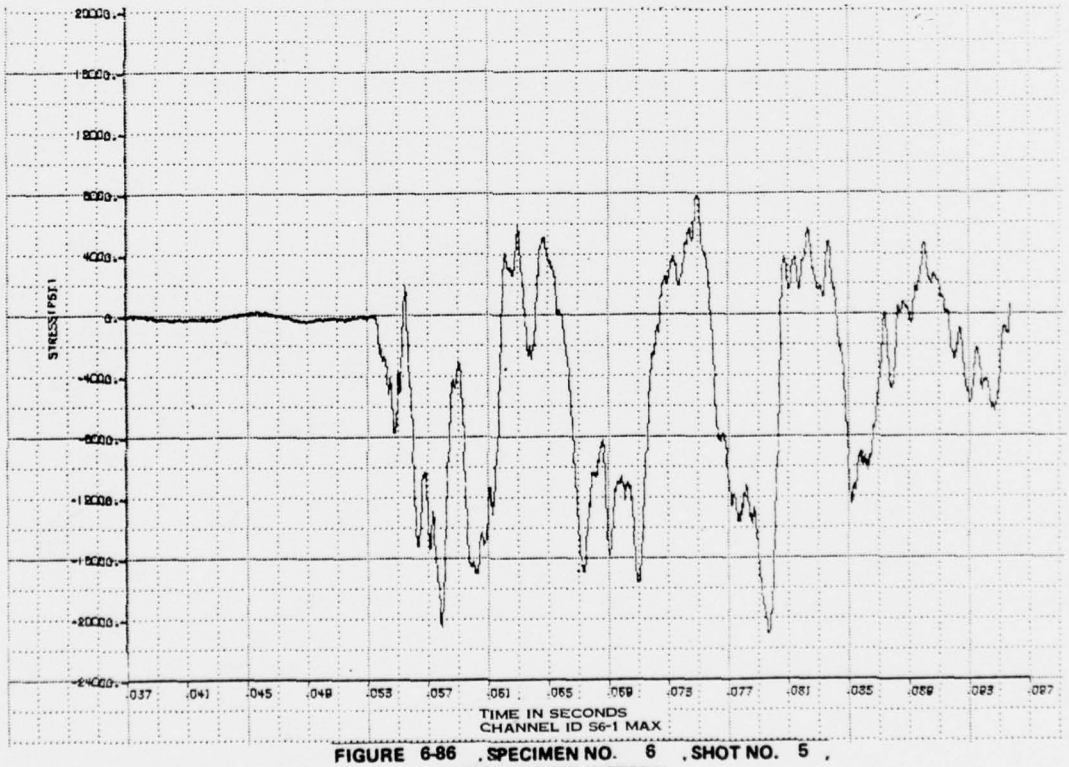


FIGURE 6-86 , SPECIMEN NO. 6 , SHOT NO. 5 ,
STRESS TIME HISTORY

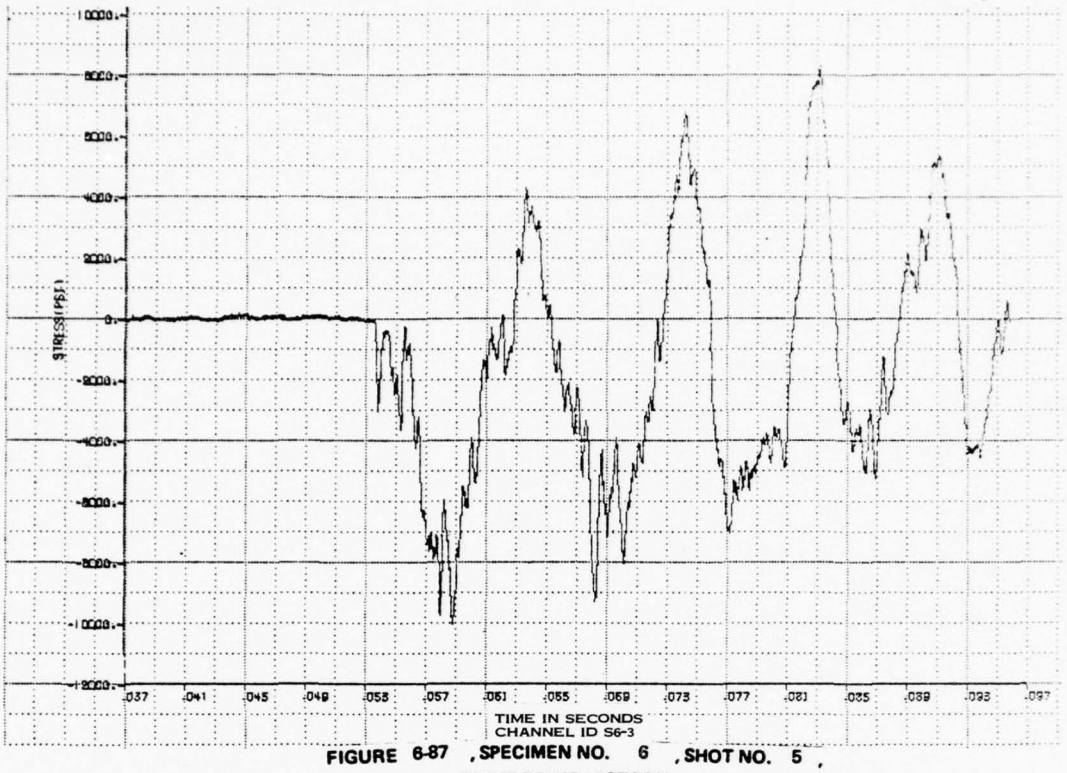


FIGURE 6-87 , SPECIMEN NO. 6 , SHOT NO. 5 ,
STRESS TIME HISTORY

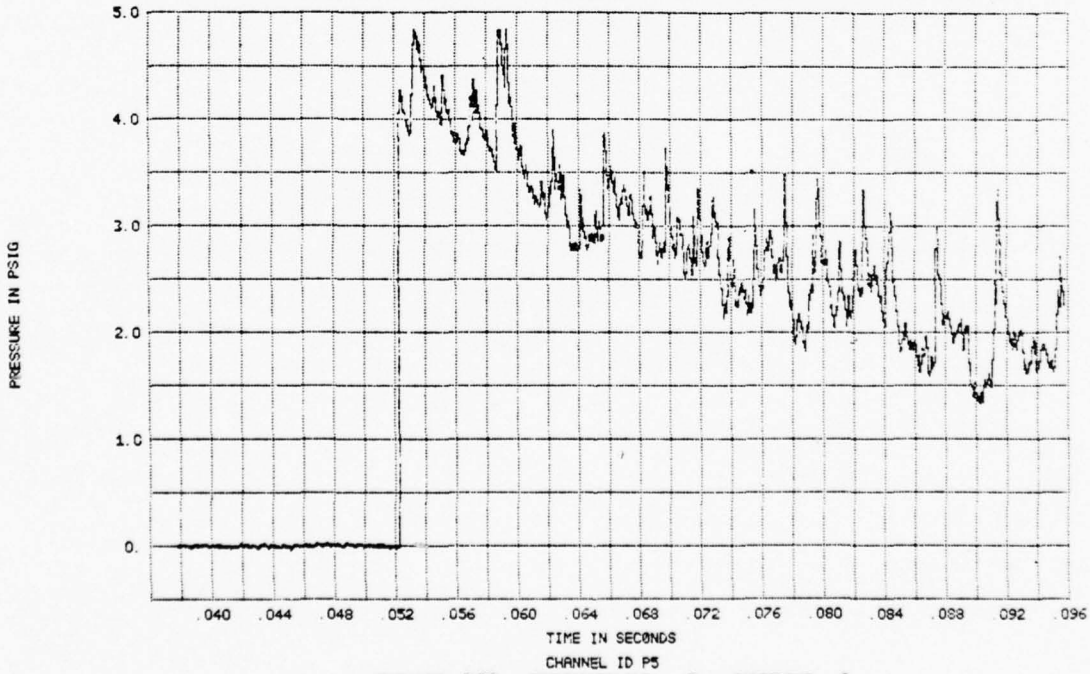


FIGURE 6-88 , SPECIMEN NO. 6 , SHOT NO. 6 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

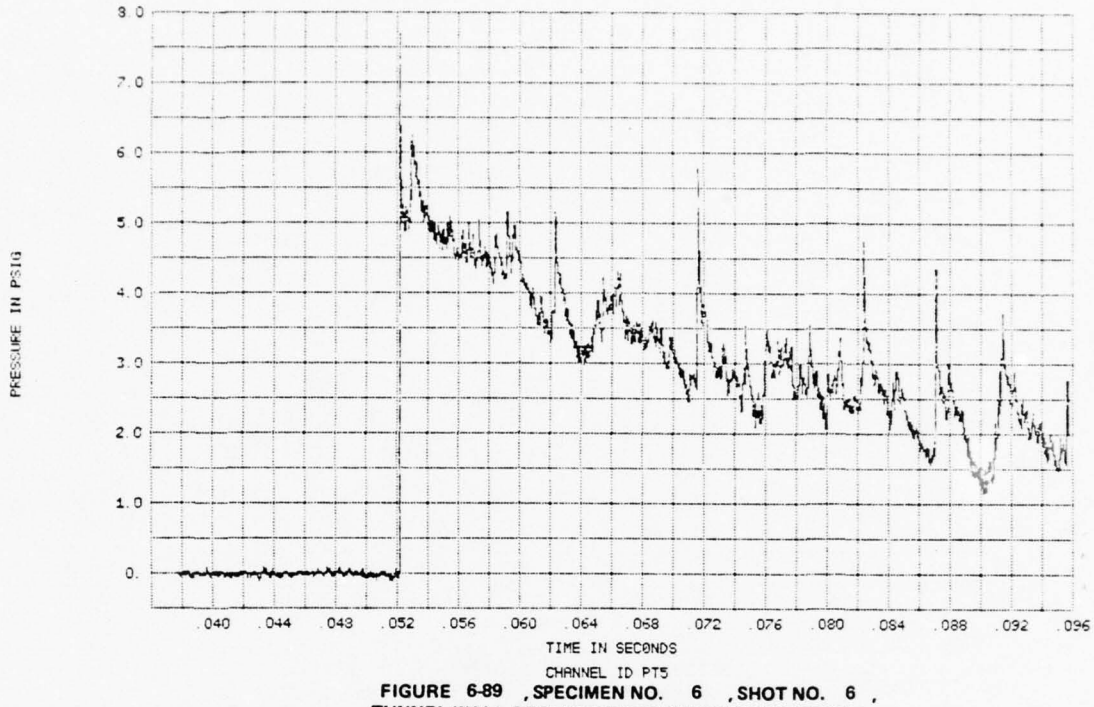


FIGURE 6-89 , SPECIMEN NO. 6 , SHOT NO. 6 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

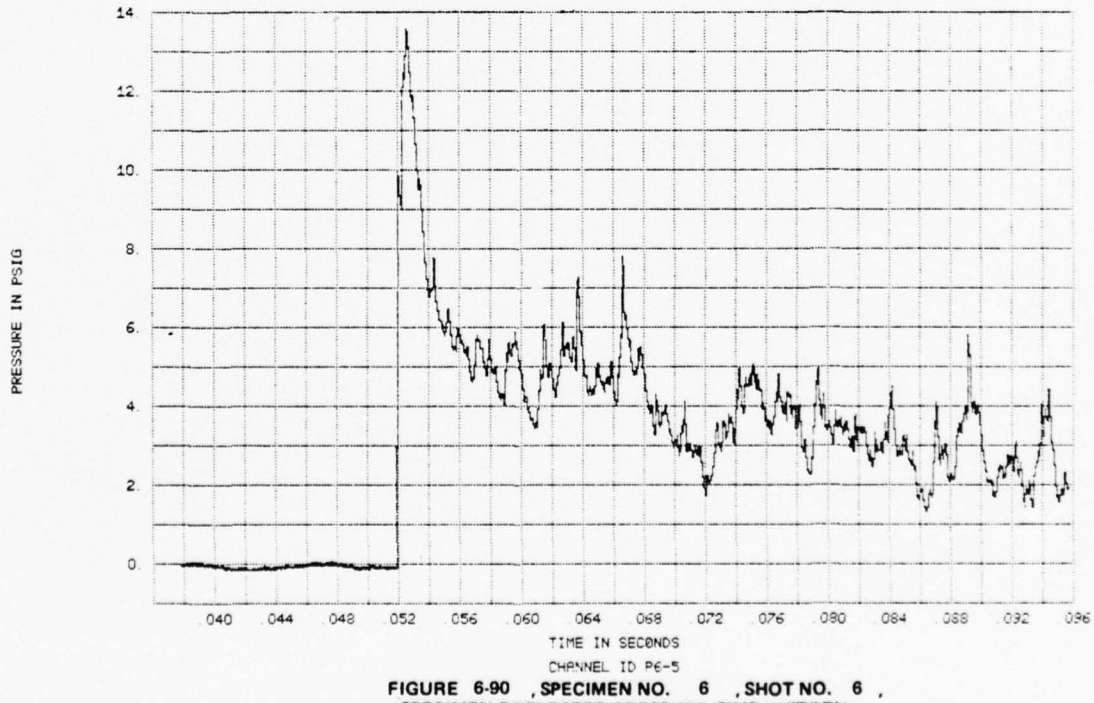


FIGURE 6-90 , SPECIMEN NO. 6 , SHOT NO. 6 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

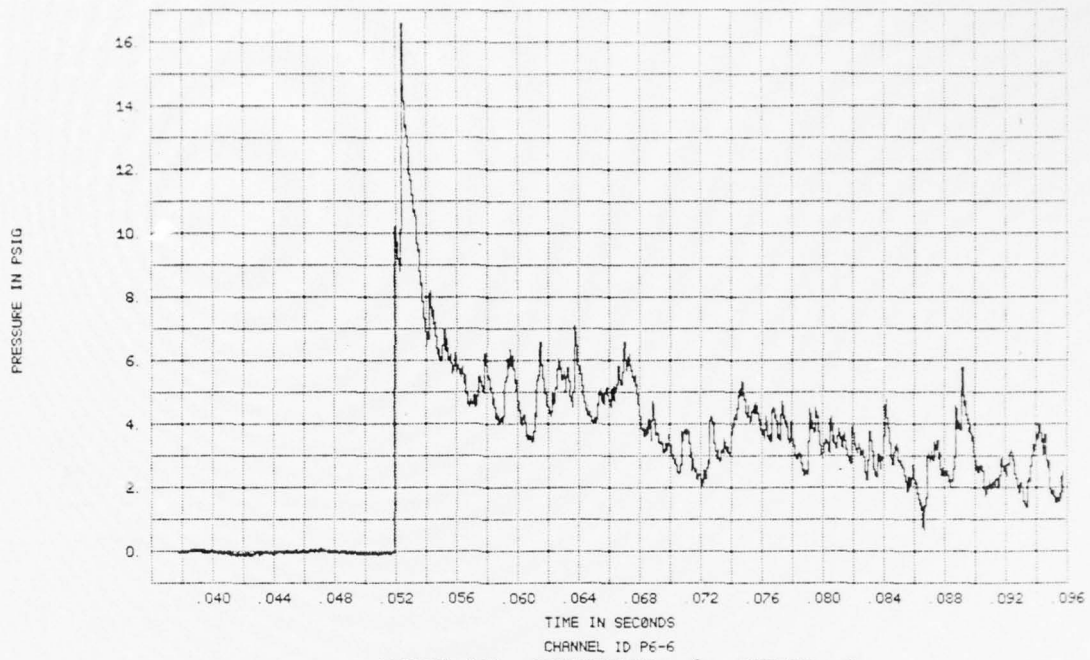


FIGURE 6-91 , SPECIMEN NO. 6 , SHOT NO. 6 , SPECIMEN REFLECTED PRESSURE TIME HISTORY

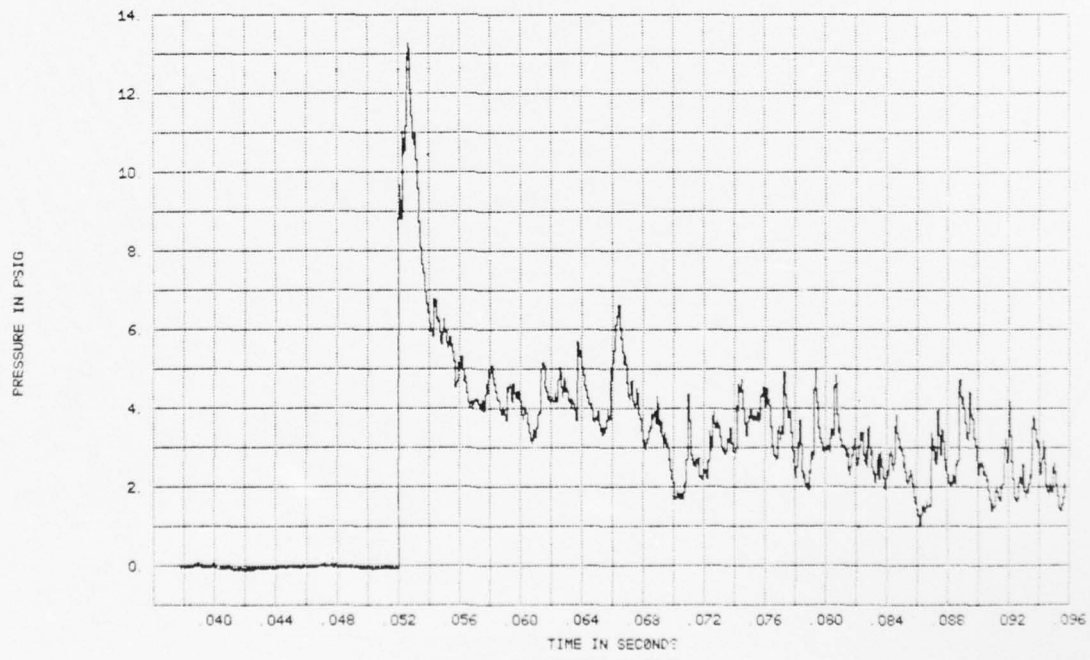


FIGURE 6-92 , SPECIMEN NO. 6 , SHOT NO. 6 , SPECIMEN REFLECTED PRESSURE TIME HISTORY

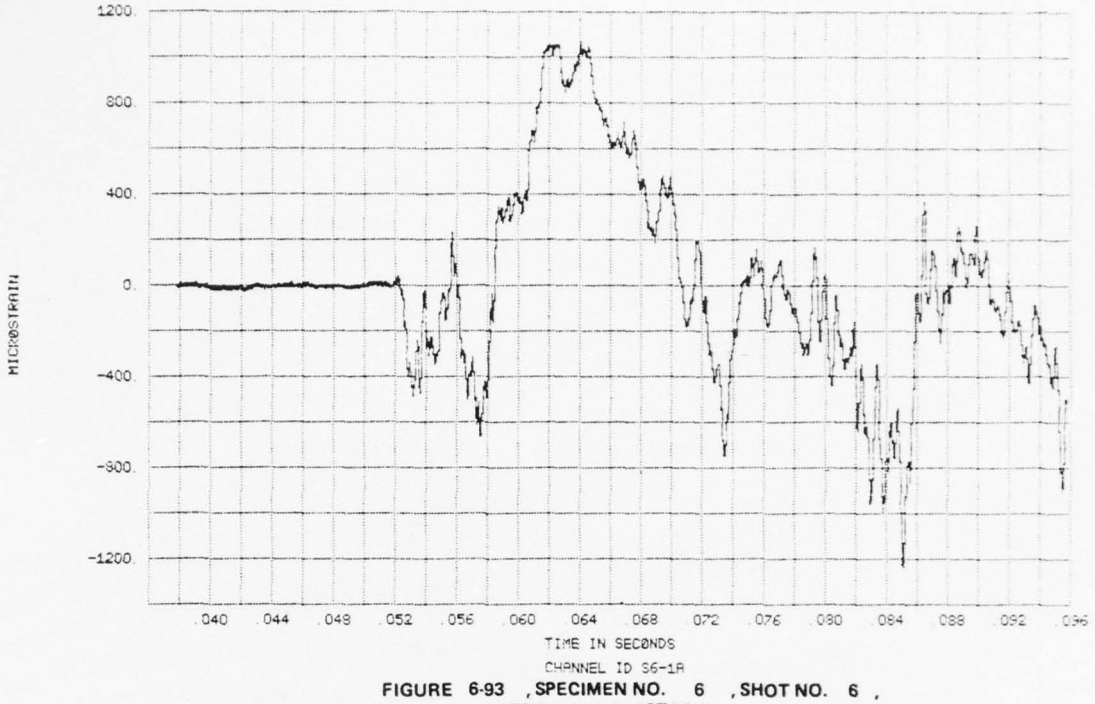


FIGURE 6-93 , SPECIMEN NO. 6 , SHOT NO. 6 , STRAIN TIME HISTORY

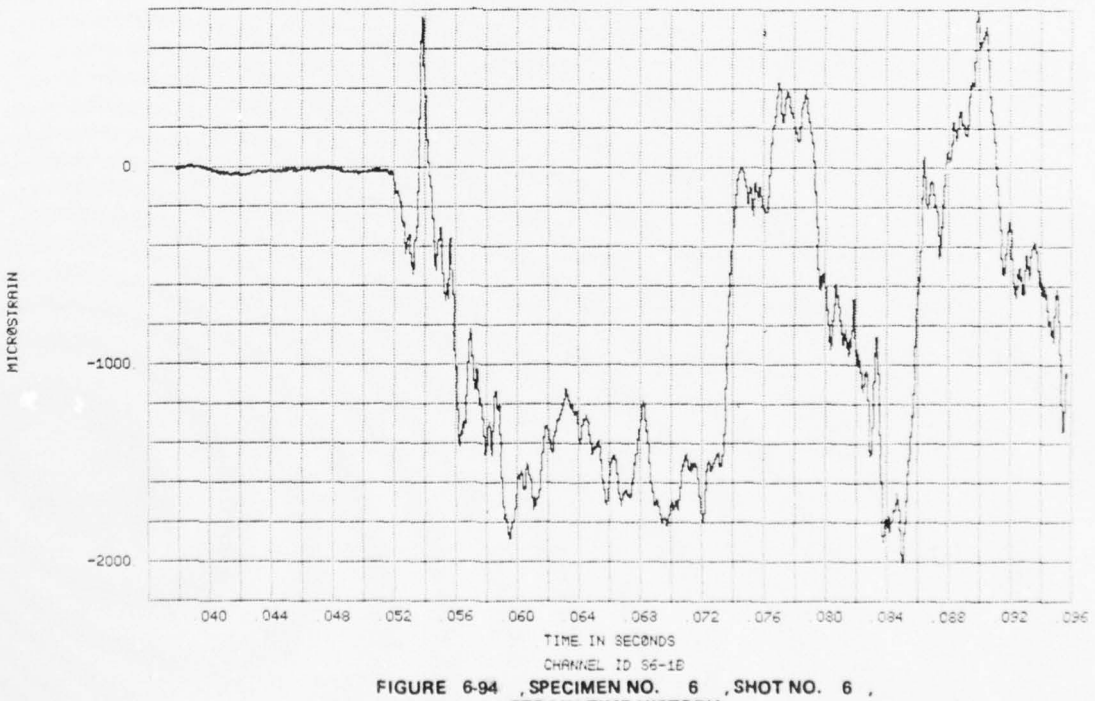


FIGURE 6-94 , SPECIMEN NO. 6 , SHOT NO. 6 , STRAIN TIME HISTORY

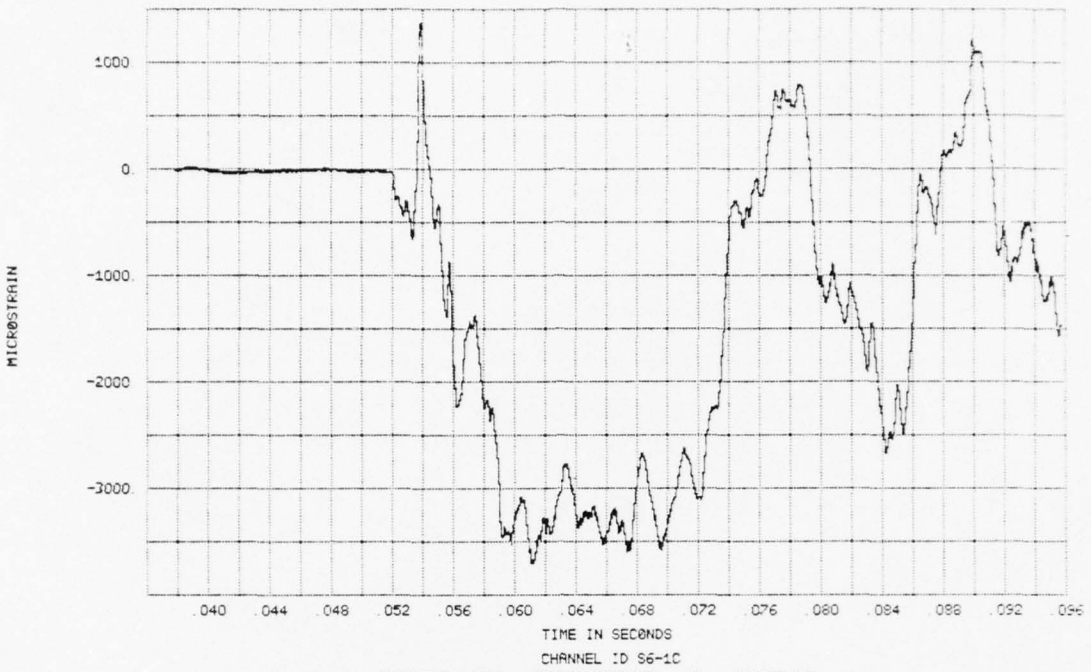


FIGURE 6-95 , SPECIMEN NO. 6 , SHOT NO. 6 , STRAIN TIME HISTORY

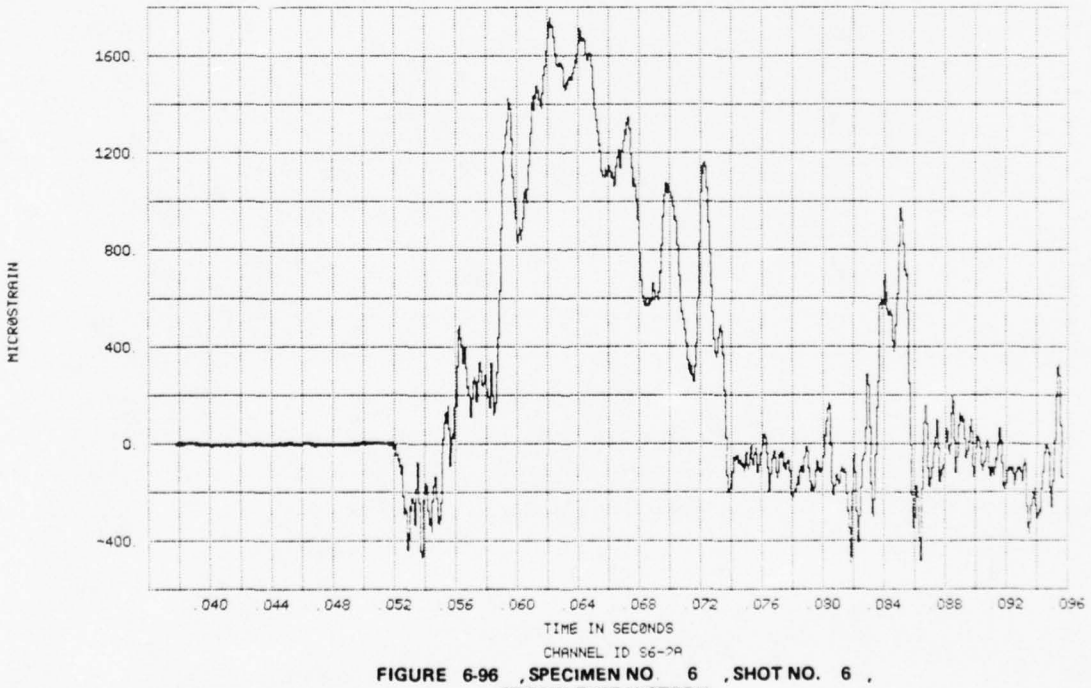


FIGURE 6-96 , SPECIMEN NO. 6 , SHOT NO. 6 , STRAIN TIME HISTORY

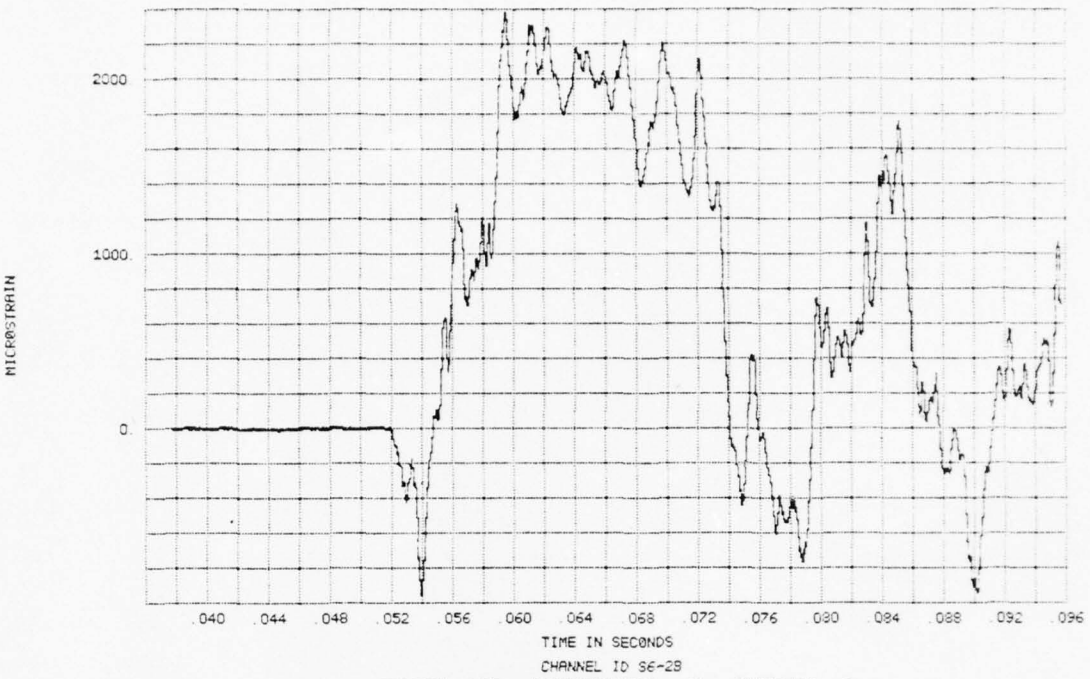


FIGURE 6-97 , SPECIMEN NO. 6 , SHOT NO. 6 , STRAIN TIME HISTORY

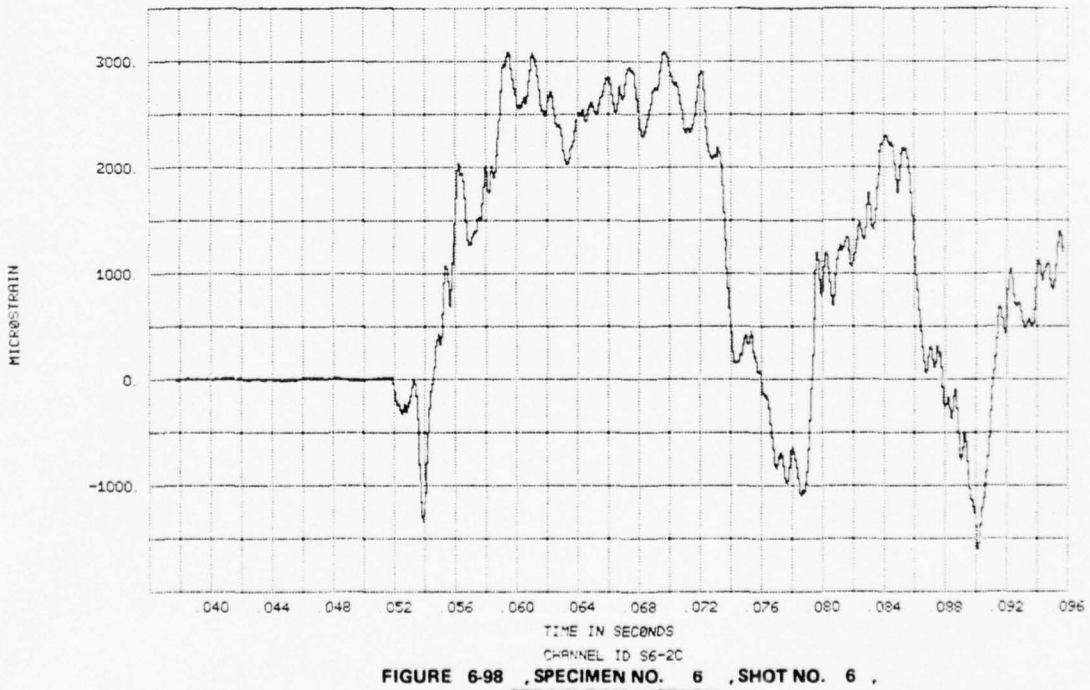


FIGURE 6-98 , SPECIMEN NO. 6 , SHOT NO. 6 , STRAIN TIME HISTORY

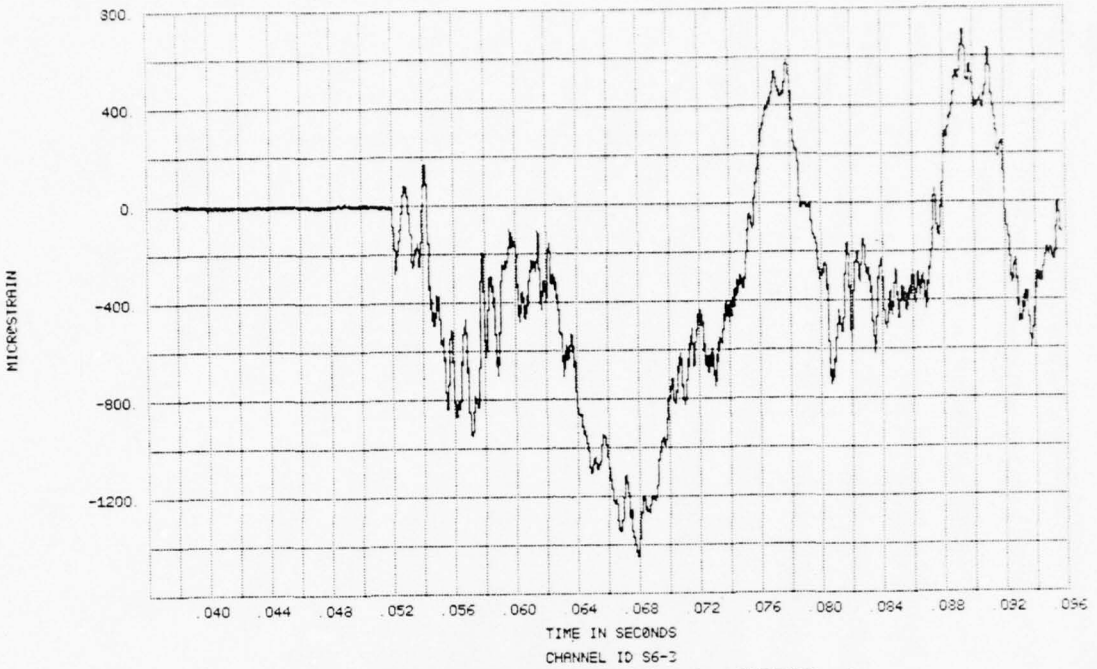


FIGURE 6-99 , SPECIMEN NO. 6 , SHOT NO. 6 , STRAIN TIME HISTORY

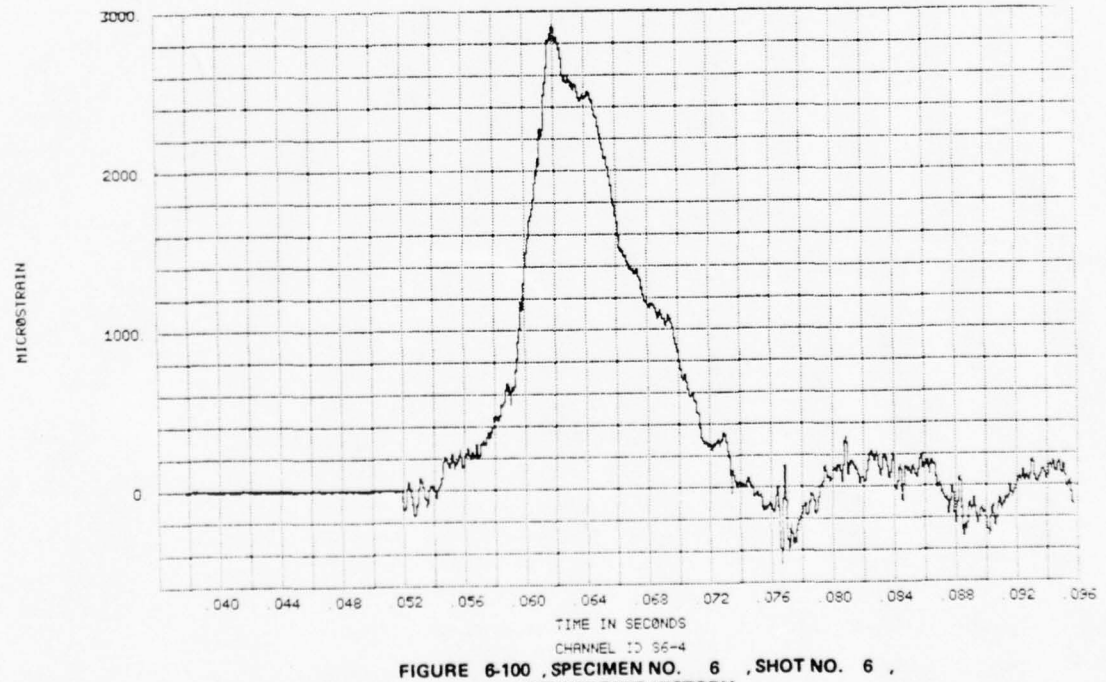
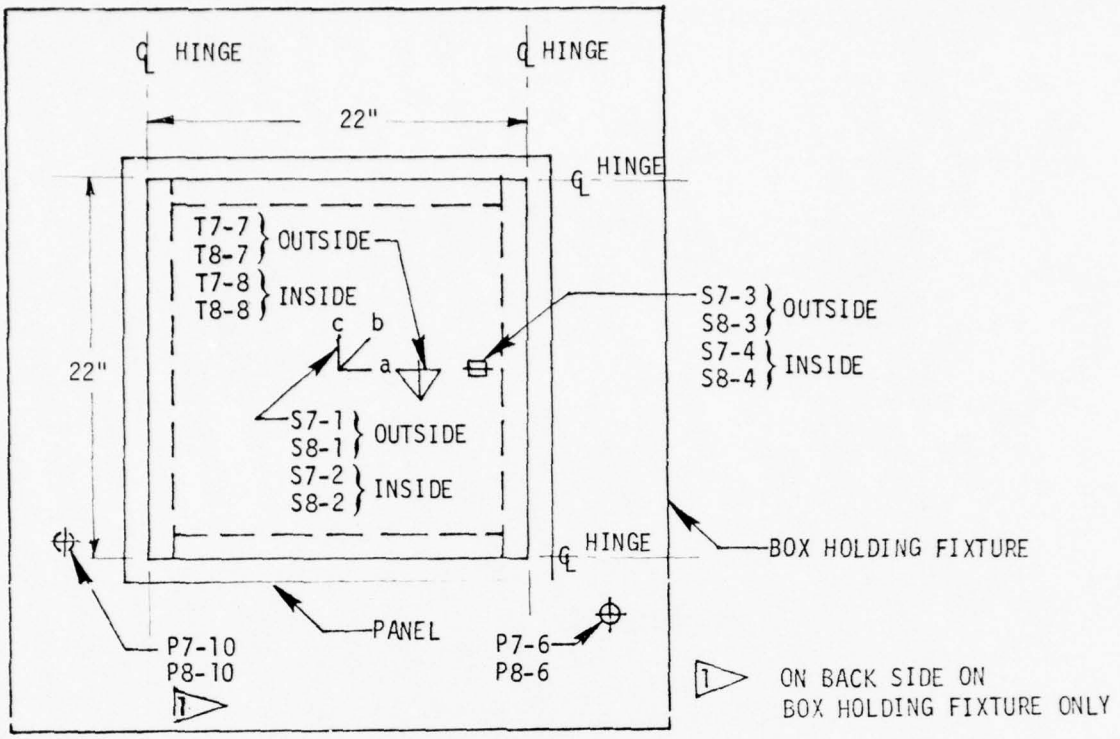


FIGURE 6-100 , SPECIMEN NO. 6 , SHOT NO. 6 , STRAIN TIME HISTORY

SPEC NOS. 7 & 8



SPECIMEN NO. 7 & 8

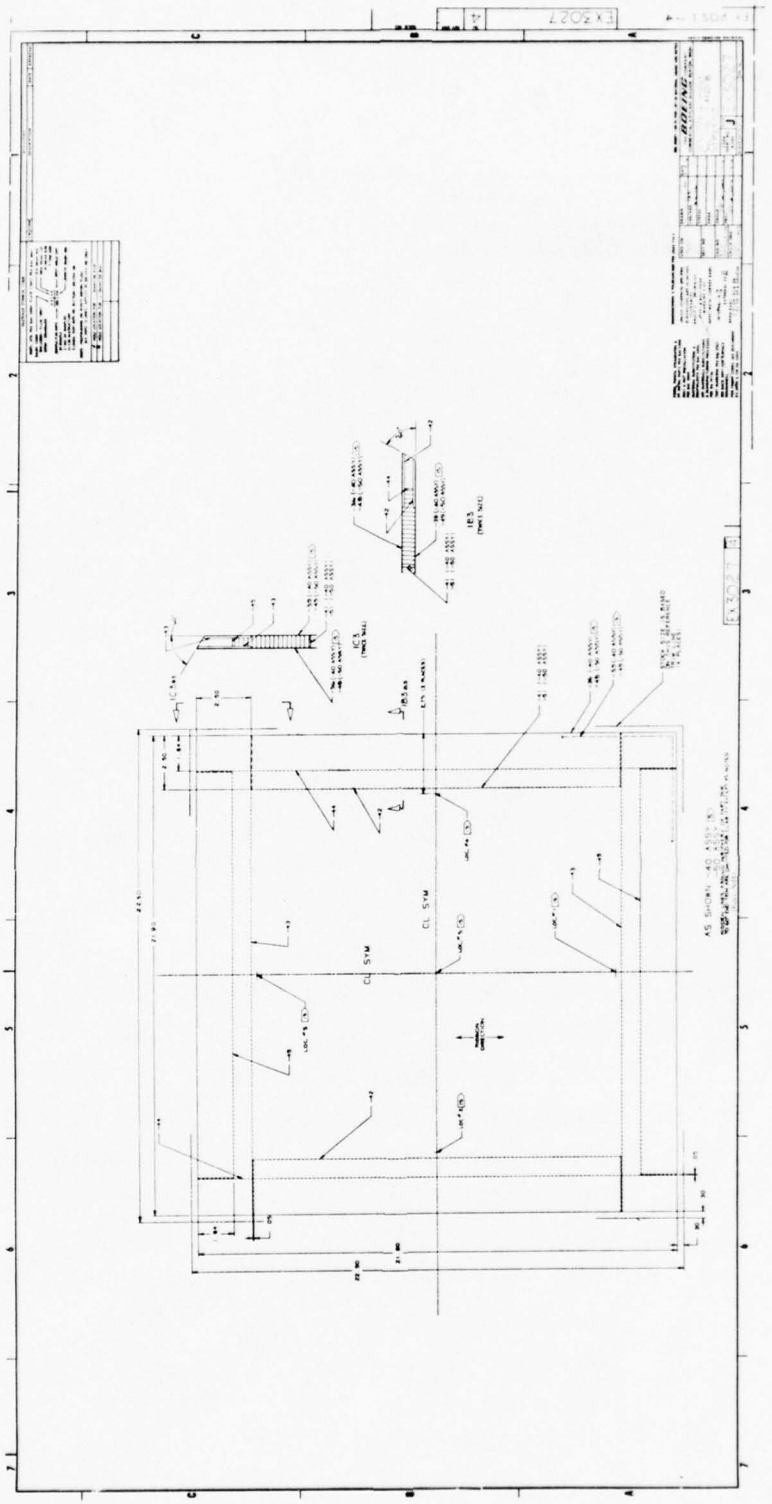
FLAT HONEYCOMB PANELS

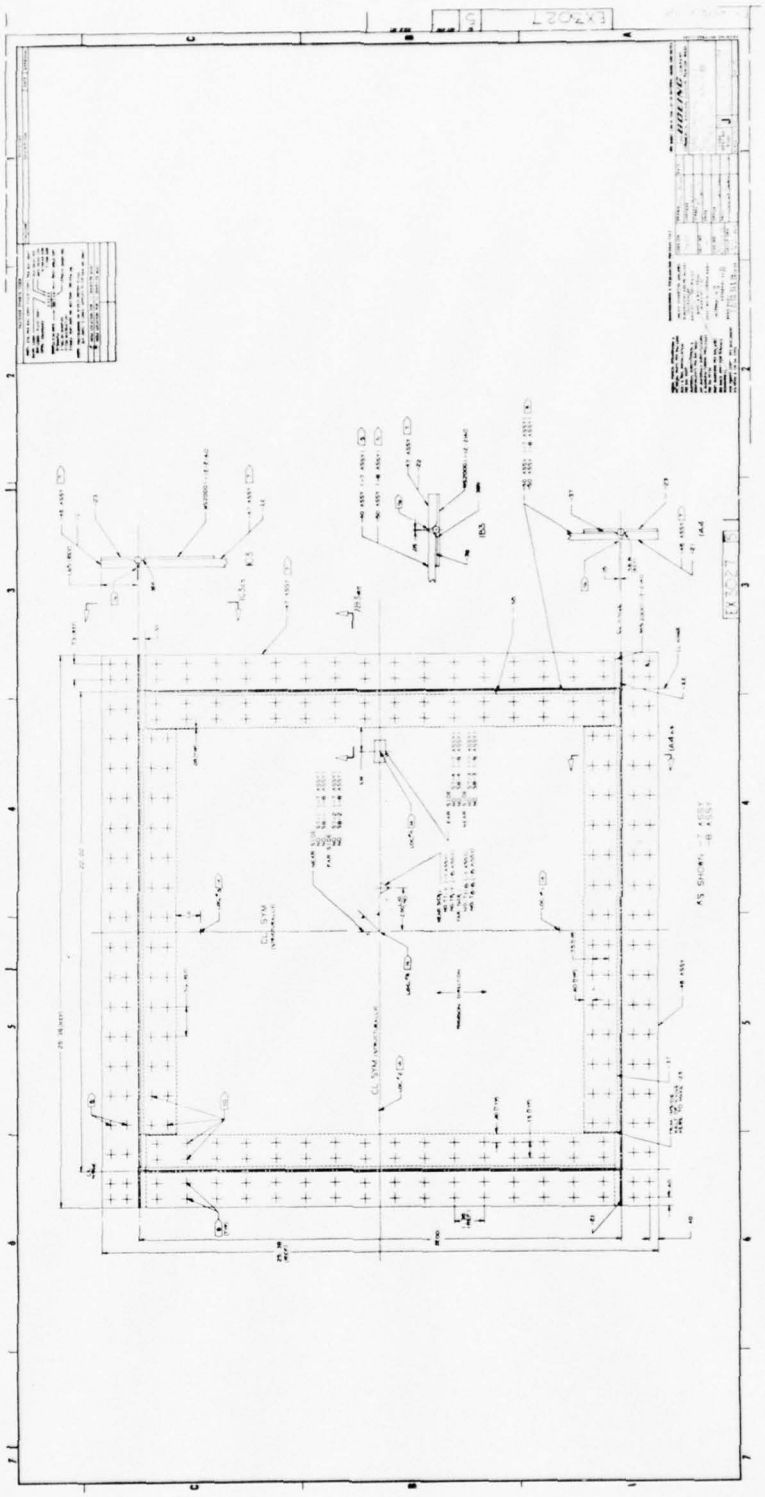
FOUR SIDES PINNED

MATERIAL - 5052-0 ALUMINUM ALLOY

POISSON'S RATIO - .33

SPECIMEN NO. 7		SPECIMEN NO. 8
.0002539 lb-sec^2/in^4	FACE SHEET DENSITY (MIL-HDBK-5)	.0002539 lb-sec^2/in^4
9.745 x 10^{-6} lb-sec^2/in^4	CORE DENSITY	1.214 x 10^{-5} lb-sec^2/in^4
12.3 x 10^6 PSI	FACE SHEET MODULUS OF ELASTICITY	12.3 x 10^6 PSI
3.85 x 10^6 PSI	FACE SHEET SHEAR MODULUS	3.85 x 10^6 PSI
67,275 PSI	CORE SHEAR MODULUS	88,900 PSI
21.0	FACE SHEET % ELONGATION	21.0
13,270 PSI	FACE SHEET TENSILE YIELD	13,270 PSI
30,300 PSI	FACE SHEET TENSILE RUPTURE	30,300 PSI
300 PSI	CORE SHEAR STRENGTH	400 PSI
.013 IN.	INNER FACE SHEET THICKNESS	.013 IN.
3/8 IN.	CORE CELL SIZE	1/8 IN.
.3065 IN.	CORE THICKNESS	.292 IN.
.0135 IN.	OUTER FACE SHEET THICKNESS	.014 IN.
MIL-C-7438 6.5-3/8-50	CORE SPECIFICATION	MIL-C-7438 8.1-1/8-20





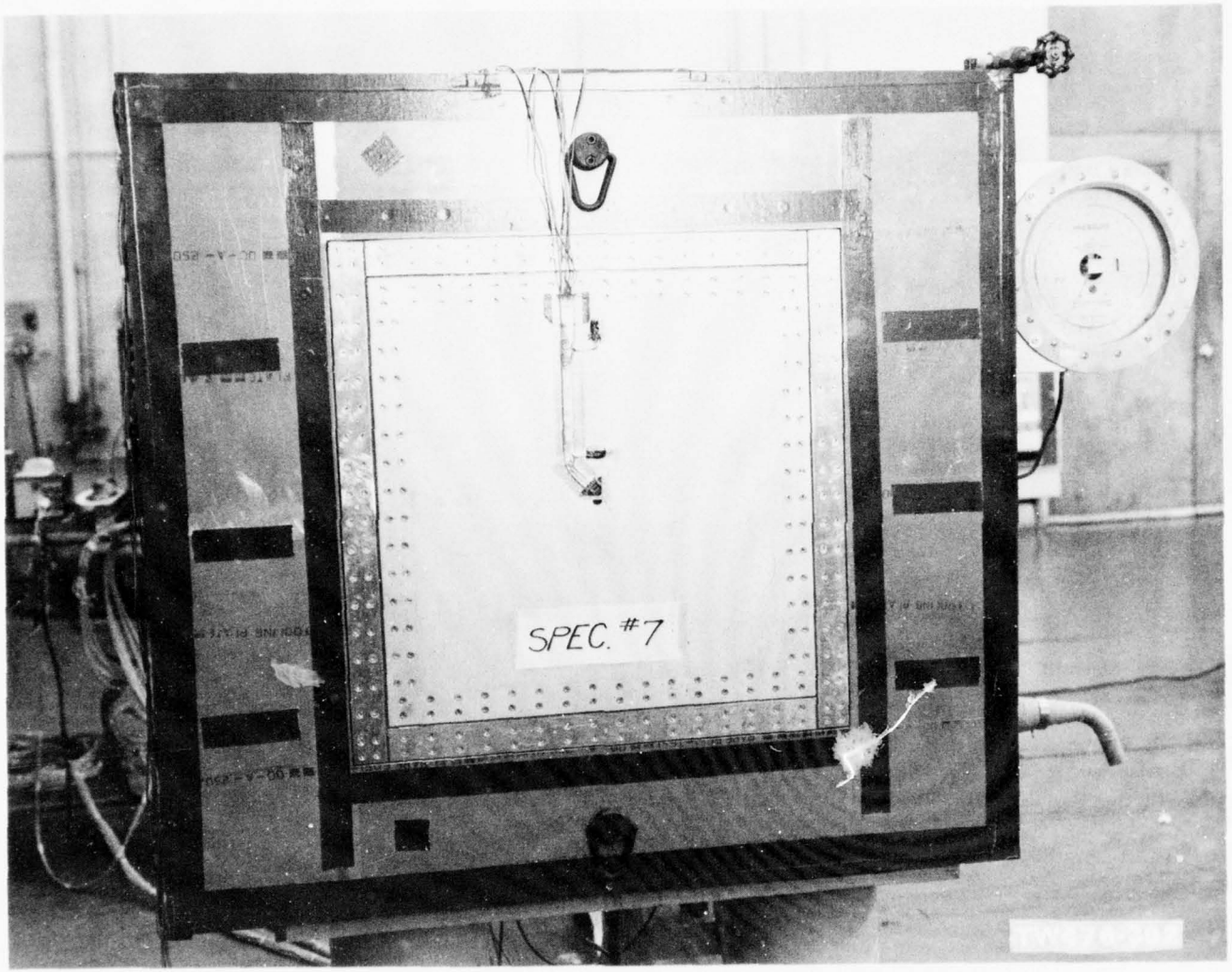


FIGURE 7-1 - SPECIMEN NO. 7 - TEST SET-UP



FIGURE 7-2 - SPECIMEN NO. 7 - INSTRUMENTATION - FRONT

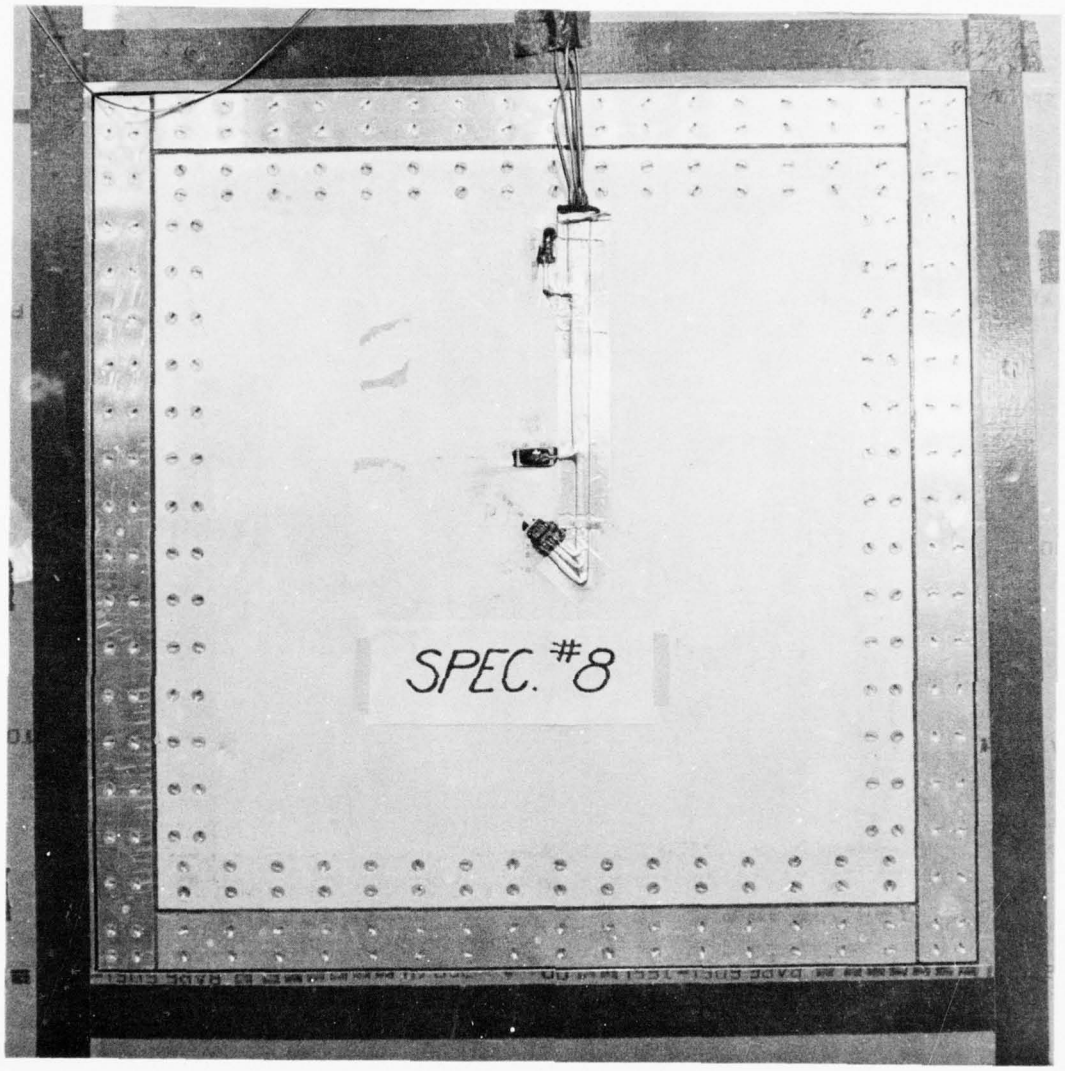


FIGURE 8-1 - SPECIMEN NO. 9 - INSTRUMENTATION - FRONT

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO. 7 - STATIC ANALYSIS - PRESS = 2.0 PSI - 0.0775 - APS
     1
0.0          0.1          0.01         0.0
0.0          0.0          0.0          0.0
          15           15
100000.

               2            0
               2
               6            0
               6            0
               2            2
0.0            0.0
0.0            42.0
-42.0          0.0
-42.0          42.0
               0
               4            3            1
-21.0          0.0          21.0
-2.0
               -            3           11           11
               3            2            1
              15
               2            5
               3            4
               3            3
               4            3
               4            2
               4            1
               5            2
               5            3
               5            4
               5            5
               3
22.0           22.0
0.013          0.0002539
12300000.      12300000.    0.33         0.33         3850000.
13270.         13270.
0.3195         9.745   E-06
1.0            1.0          0.01         0.01         87275.
750.0          750.0
0.333          0.0002539
12300000.      12300000.    0.33         0.33         3850000.
13270.         13270.
0.0            0.0          0.0          0.0          0.0          0.0
0.0            0.0          0.0          0.0          0.0          0.0
0.0            0.0          0.0          0.0          0.0          0.0
0.0            0.0          0.0          0.0          0.0          0.0
0.0
.000001        .000001      1.0
```

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.  1 - STATIC ANALYSIS - PRESS = 2.0 PSI - MOMTS - RPS
         1                3
0.0          0.1          0.01         0.0
0.0          0.0          0.0          0.0
        15           15
100000.
         2            0
         2
         6            0
         0            0
         2            2
0.0          0.0
0.0          0.0
-42.0        0.0
-42.0        0.0
         0
         4            3            1
-21.0        0.0          21.0
-2.0
         0            0           11           11
         2            2            1
        10
         2            0
         0            4
         0            0
         4            0
         4            4
         4            2
         0            2
         0            3
         0            4
         0            0
         6
22.0         22.0
0.013        0.0002539
12300000.    12300000.    0.33         0.33         3850000.
13270.       13270.
0.305        1.214   E-05
1.0          1.0          0.01         0.01         93900.
1100.        1100.
0.319        0.0002539
12300000.    12300000.    0.33         0.33         3850000.
13270.       13270.
0.0          0.0          0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0          0.0          0.0
0.0
.000001      .000001      1.0
```

HONEYCOMB PANEL - LOAD/STRESS/DEFLECTION DERIVATION

The panel experiences two kinds of stresses.

- Bending, as a plate
- Tension, as two separate membranes (skins)

For comparison purposes, this analysis will correlate to data obtained from static tests of simply supported honeycomb square panels under uniform pressure. The tested panels have a 22 inch span, are .333 in. thick overall with skin thickness of .0135 in. each and have a modulus of elasticity of 12.3×10^6 psi.

Past analyses of honeycomb panels have computed an equivalent thickness in homogeneous material and derived stresses using this value. In order to select the proper analysis method, it must first be determined which category (thick plate, thin plate or membrane) best fits the panel. It now appears that using the equivalent thickness, rather than the actual thickness, to select this category is probably in error.

For the subject panels, the span/thickness ratio (using the panel actual thickness) establishes these panels as thick plates.

$(b/t = 22/.333 = 66)$*

It will be assumed that some part of the total pressure will be resisted by panel bending - - call this portion, P_p. The remainder of the total pressure will be resisted by membrane action - - call this portion, P_m. Therefore, $P_{Total} = P_p + 2\,P_m$ (since there are two membranes).

For this analysis, the equivalent thickness, t_e, shall be simply = $\sqrt[3]{12I}$, where

$$I = 2\,t_s \left(\frac{t - t_s}{2}\right)^2$$

t_s = skin thickness = .0135 in.

t = panel overall thickness = .333 in.

therefore, $I = .00069$ in^4/in.

and $t_e = .202$ in.

From *, the following relationships are obtained:

For a thick plate: $\delta = \dfrac{\alpha P b^4}{E t_e^3}$ (Deflection)

$M = \beta P b^2$ (Bending Moment at Center of Panel)

*"Airplane Structural Analysis and Design", Sechler and Dunn.

or, since $f = \frac{Mc}{I} = \frac{12Mc}{t_e^3} = \frac{12\beta_1 Pb^2c}{t_e^3}$ (Stress)

For a membrane: $\delta = n_1 b \sqrt[3]{\frac{Pb}{Et_s}}$ (Deflection)

$$f = n_2 \sqrt[3]{E\left(\frac{Pb}{t_s}\right)^2}$$ (Stress)

where:

b = Panel span (in.)
P = Pressure (psi)
= Deflection (in.)
E = Modulus of Elasticity (psi)
c = Actual distance to extreme fiber from the neutral axis (in.) (in this case, $c = \frac{t}{2} = .1665$ in.)

α = Thick plate coefficient for deflection
β_1 = Thick plate ocefficient for stress
n_1 = Membrane coefficient for deflection
n_2 = Membrane coefficient for stress

at a/b = 1 (square panel)*

$\alpha = .045$ $n_1 = .315$
$\beta_1 = .048$ $n_2 = .26$ (at center of panel)

Since the total deflection is the same for the thick plate as for the membranes -

(2) $P_p = \frac{\delta E t_e^3}{\alpha b^4}$

(3) & (1) $P_m = \left(\frac{\delta}{n_1 b}\right)^3 \frac{E t_s}{b} = \left(\frac{\delta}{n_1}\right)^3 \frac{E t_s}{b^4}$

From (1)

(4) $P_{TOTAL} = \frac{\delta E t_e^3}{\alpha b^4} + \frac{2 E t_s}{b^4}\left(\frac{\delta}{n_1}\right)^3 = \frac{E}{b^4}\left[\frac{\delta t_e^3}{\alpha} + 2 t_s \left(\frac{\delta}{n_1}\right)^3\right]$

The relationship between P and δ is now established and can be plotted. Then from the plot, δ can be determined for any value of P.

*"Airplane Structural Analysis and Design", Sechler and Dunn

Combining and re-writing the equations on Page 356:

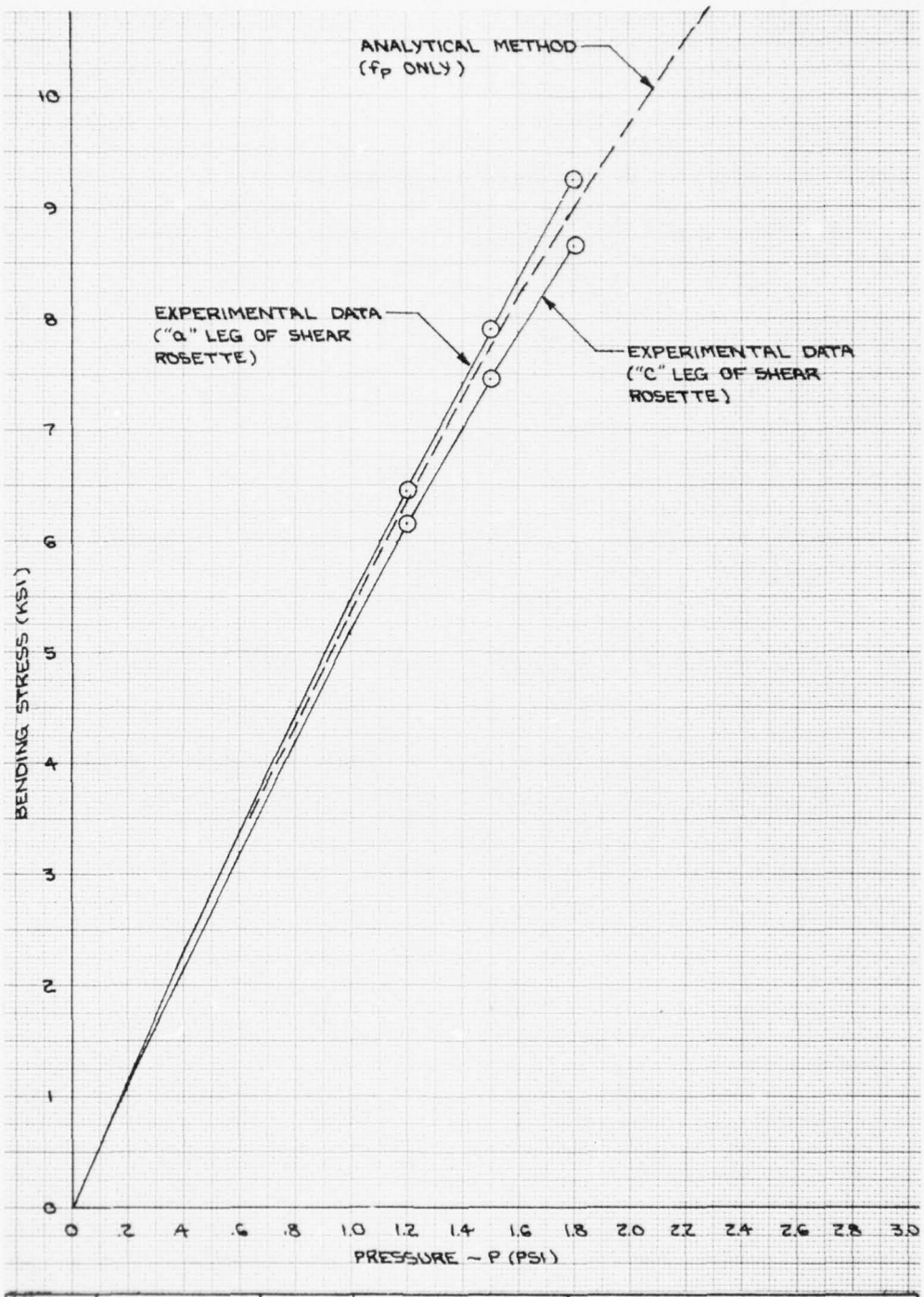
(5) $f_p = \frac{12 \theta_1 c E \delta}{\alpha b^2}$

(6) $\xi \quad f_m = n_2 E \left(\frac{\delta}{b n_1} \right)^2$

since $f_{total} = \pm f_p + f_m$

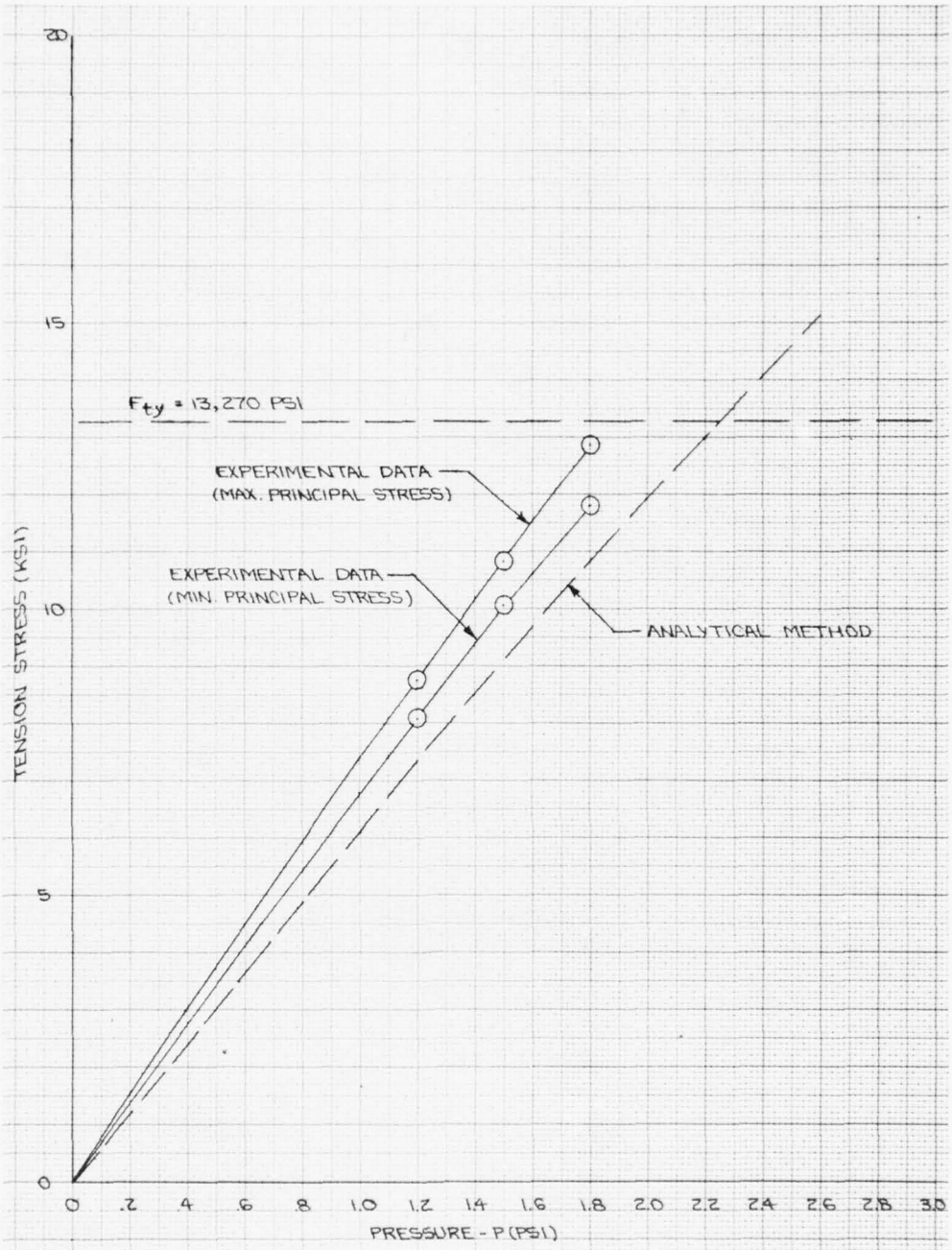
(7) $f_{total} = \frac{E \delta}{b^2} \left(\pm \frac{12 \theta_1 c}{\alpha} + \frac{n_2 \delta}{n_1^2} \right)$

The total stress can now be computed from (7) once δ is determined as described above.



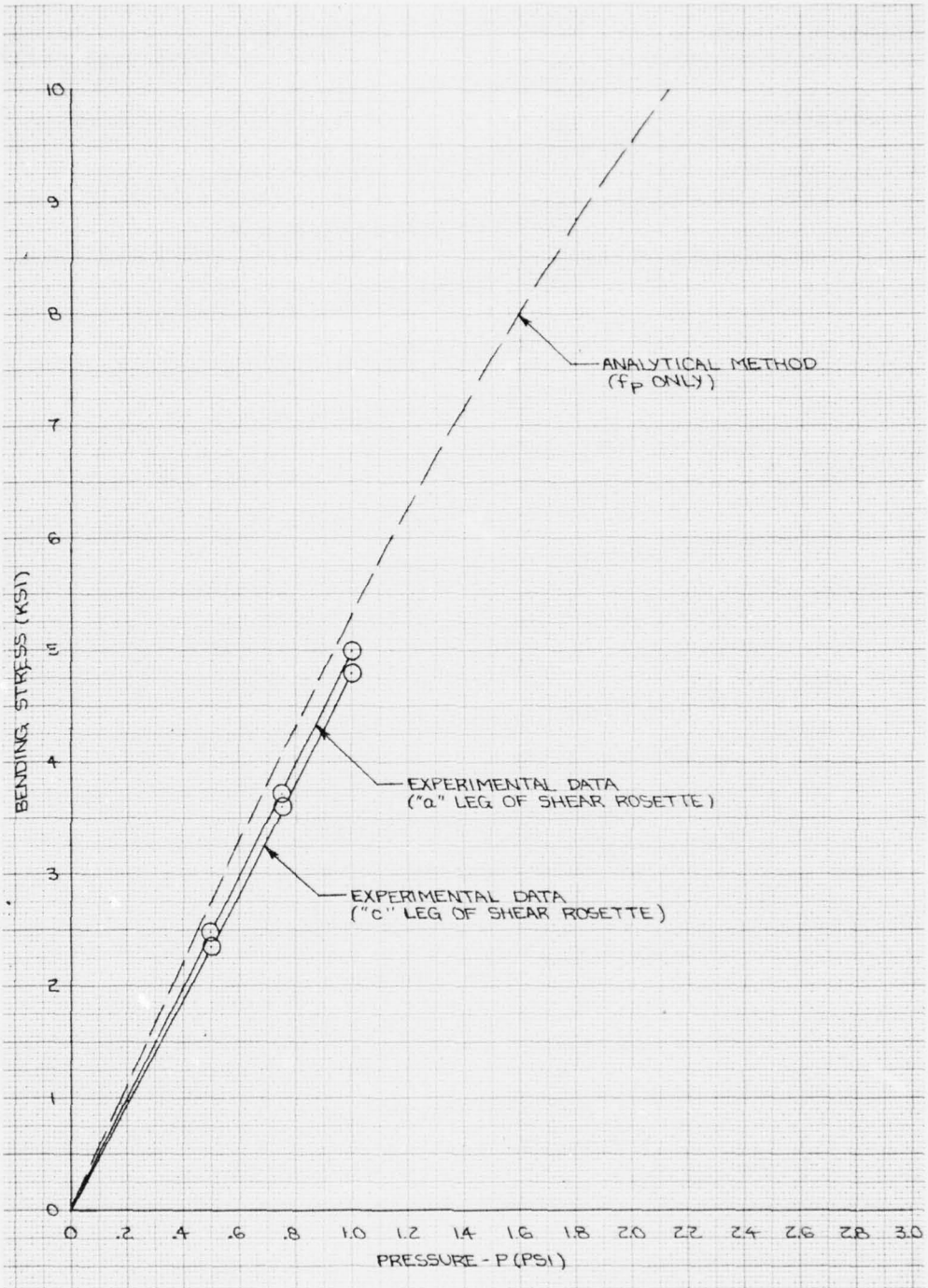
CALC	SULLENS	2-22-77
CHECK	PIERSON	3/22/77
REVISED		
REVISED		

SUBJECT: STRESS VS PRESSURE
BENDING ONLY SPECIMEN NO. 7
STATIC TEST STRESNO



CALC	SULLENS	2-22-77
CHECK	PIERSON	2/22/77
REVISED		
REVISED		

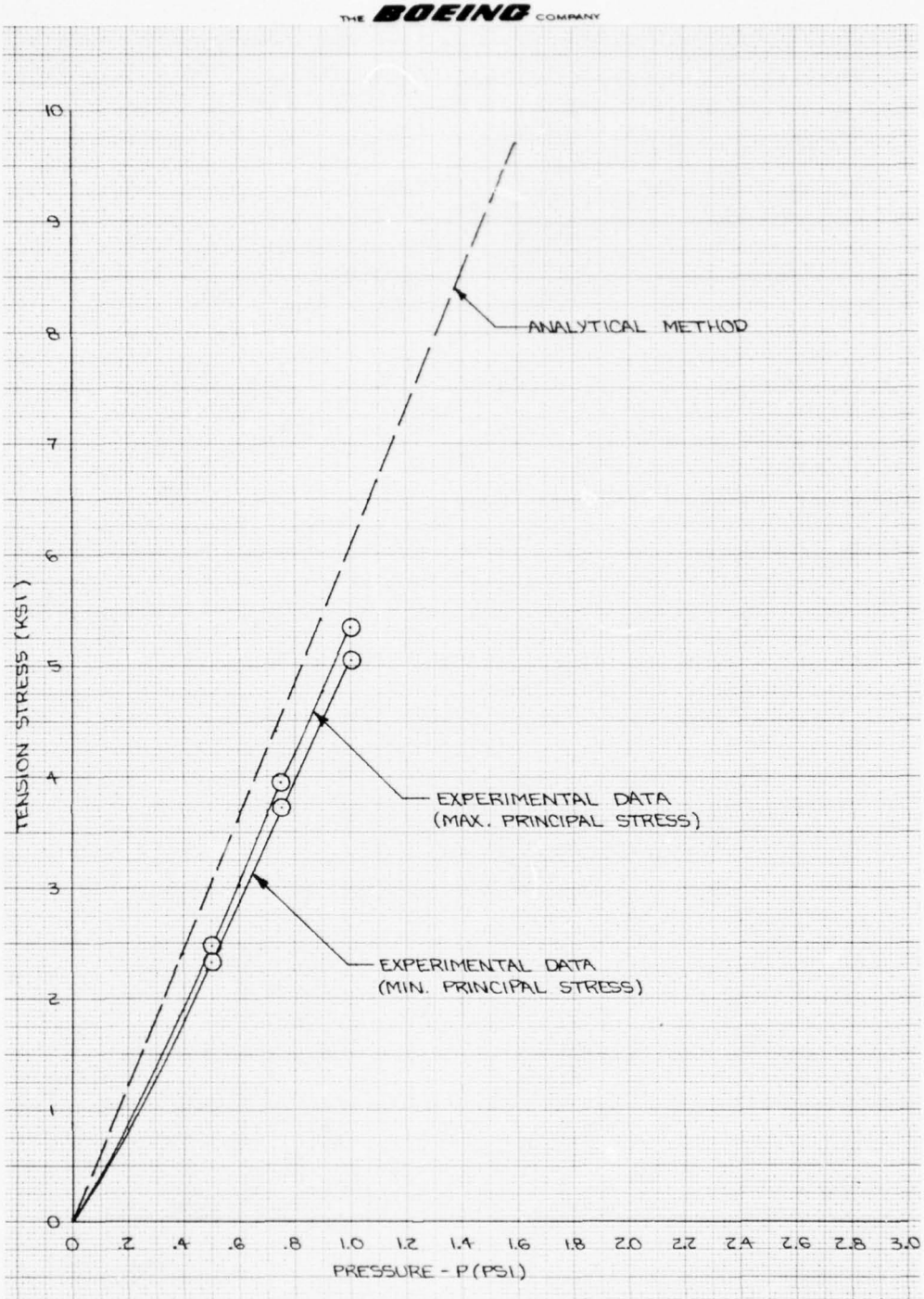
SUBJECT:
STRESS VS PRESSURE
TOTAL TENSION-SPECIMEN NO. 7
STATIC TEST STRESNO



CALC	SULLENS	2-22-77
CHECK	PIERSON	3/2/77
REVISED		
REVISED		

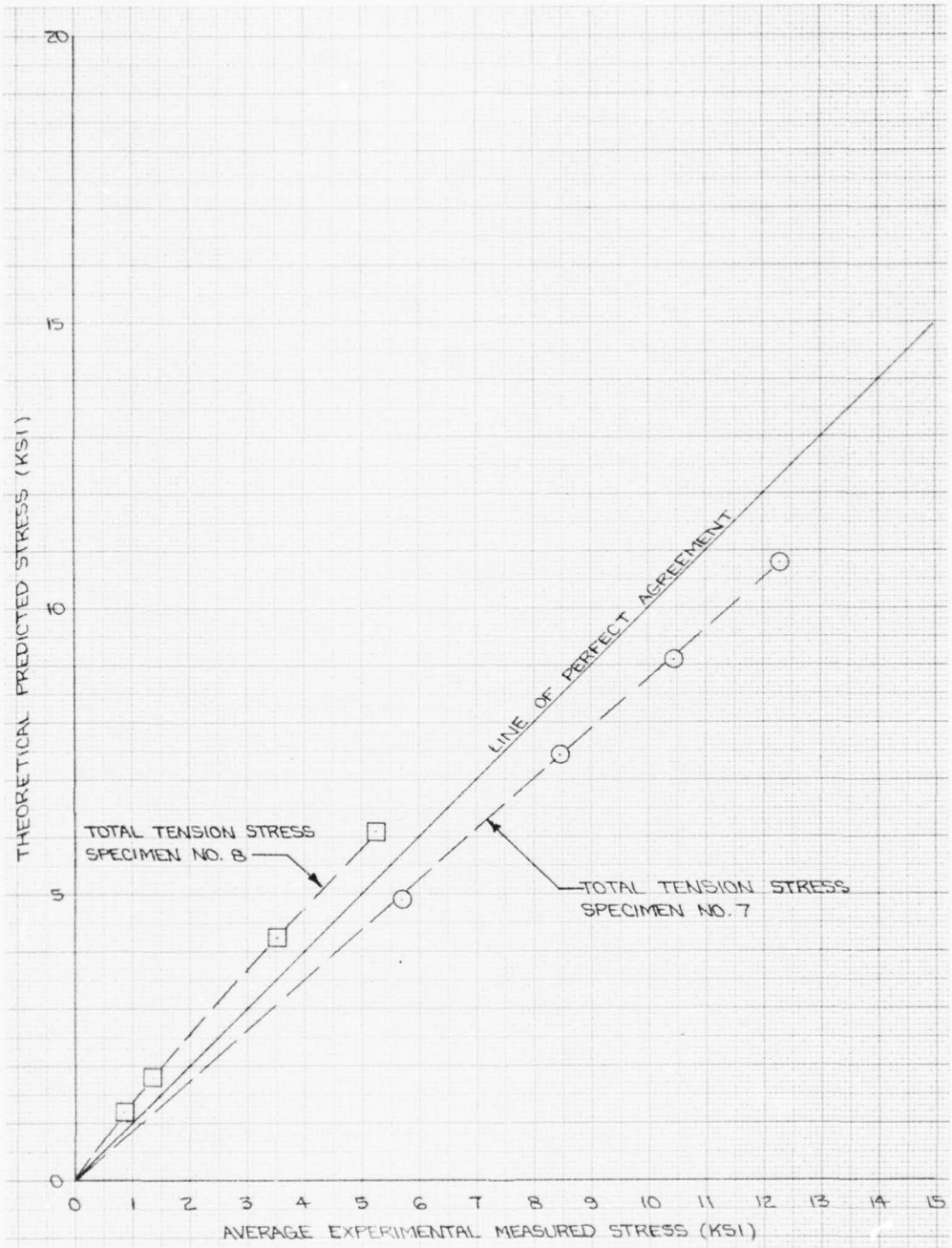
SUBJECT:
STRESS VS PRESSURE
BENDING ONLY - SPECIMEN NO. 8
STATIC TEST STRESNO

THE BOEING COMPANY



CALC	SULLENS	2-22-77
CHECK	PIERSON	2/22/77
REVISED		
REVISED		

SUBJECT:
STRESS VS PRESSURE
TOTAL TENSION - SPECIMEN NO. 8
STATIC TEST STRESNO



CALC	SULLENS	2-22-77
CHECK	PIERSON	3/22/77
REVISED		
REVISED		

SUBJECT:
THEORY VS EXPERIMENTAL
HONEYCOMB PANEL STRESSES
STRESNO - STATIC TEST

TABLE XXXII

STATIC TEST STRESSES - SPECIMEN NO. 7
(STRESSES GIVEN IN PSI)

STRAIN GAUGE	STATIC PRESSURE (PSI)		
	1.2	1.5	1.8
S7-1	-4006.	-4726.	-5414.
S7-2	8807.	10843.	12800.
S7-3	0	0	0
S7-4	1394.	1739.	2140.

TABLE XXXIII

STATIC TEST DISPLACEMENTS - SPECIMEN NO. 7
(DISPLACEMENT MEASURED AT CENTER OF PANEL)

	STATIC PRESSURE (PSI)		
	1.2	1.5	1.8
DISPLACEMENT (INCHES)	.115	.139	.162

TABLE XXXIV

STATIC TEST STRESSES - SPECIMEN NO. 8
(STRESSES GIVEN IN PSI)

STRAIN GAUGE	STATIC PRESSURE (PSI)		
	.50	.75	1.0
S8-1	-2349.	-3395.	-4428.
S8-2	2484.	3962.	5350.
S8-3	83.	70.	0
S8-4	13.	110.	276.

TABLE XXXV

STATIC TEST DISPLACEMENTS - SPECIMEN NO. 8
(DISPLACEMENT MEASURED AT CENTER OF PANEL)

	STATIC PRESSURE (PSI)		
	.50	.75	1.0
DISPLACEMENT (INCHES)	.045	.067	.088

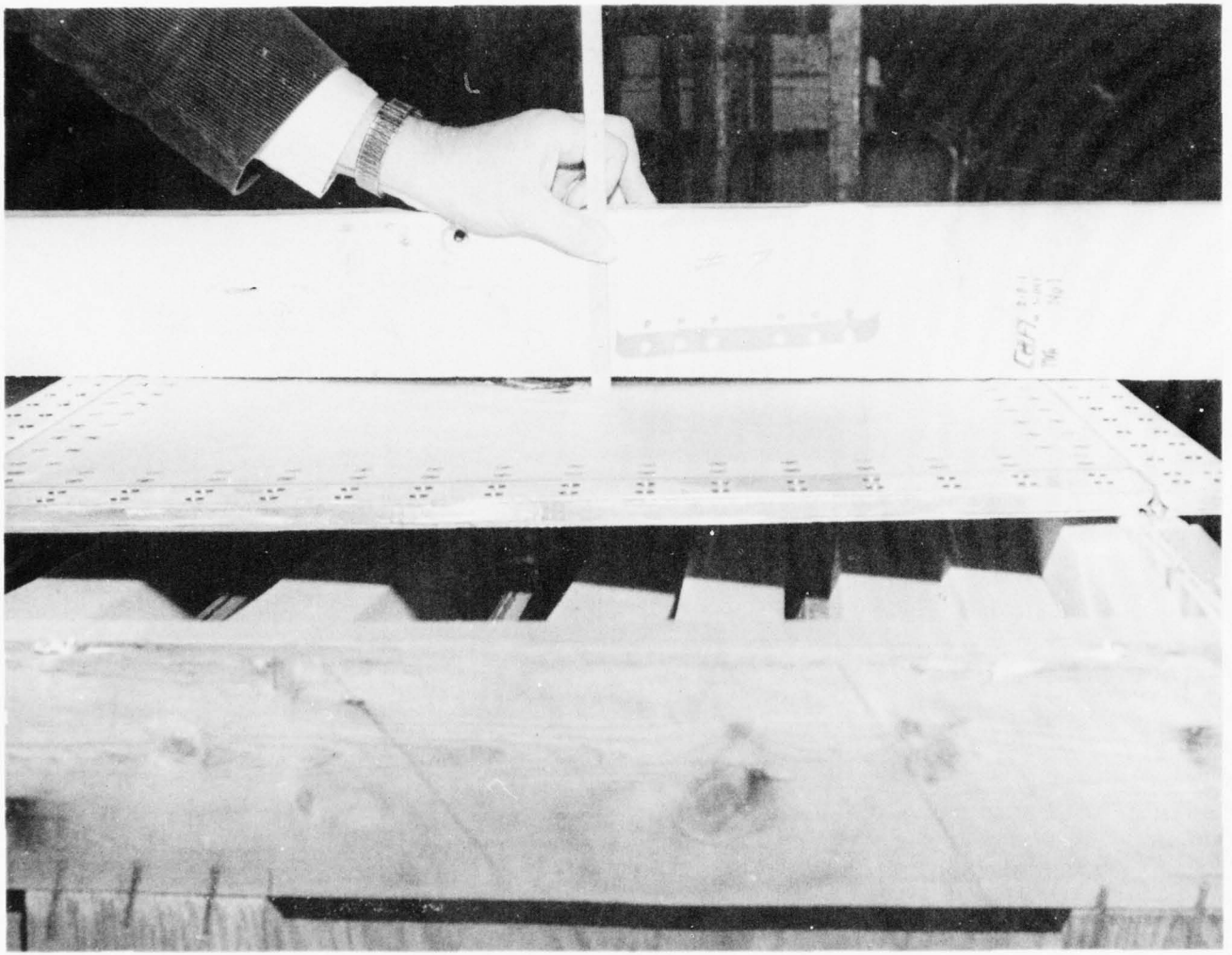


FIGURE 7-3 - SPECIMEN NO. 7 - INDICATION OF SHOCK TEST PERMANENT DEFORMATION

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.7 - DYNAMIC ANALYSIS - ITERATIVE IFP SOLUTION
          1                   2
5000.       0.001       0.02        0.0
0.0         0.0         0.0         0.0
          15          15
500.0
          2           0
          0           1
.50
          0           0
          0           0
          2           2
48.0        0.0
20.0        96.0
-60.0       0.0
-70.0       96.0
          0
          4                       1
-21.0       0.0         24.0
                                  11          11
          2           2           1                                  GPP  2
         11
          2           3
          3           4
          3           5
          4           2
          4           6
          4           5
          5           2
          5           3
          5           4
          5           5
          3
22.0        22.0
0.013       0.0002539
12300000.   12300000.   0.33        0.33        3350000.
13270.      13270.
0.3195      9.745    E-05
1.0         1.0         0.01        0.01        67275.
750.0       750.0
0.333       0.0002539
12300000.   12300000.   0.33        0.33        3350000.
13270.      13270.
132000.     67275.      0.375
0.0         0.0         0.0         0.0         0.0         0.0
0.0         0.0         0.0         0.0         0.0         0.0
0.0         0.0         0.0         0.0         0.0         0.0
0.0         0.0         0.0         0.0         0.0         0.0
0.0
0.0         0.000       0.0
```

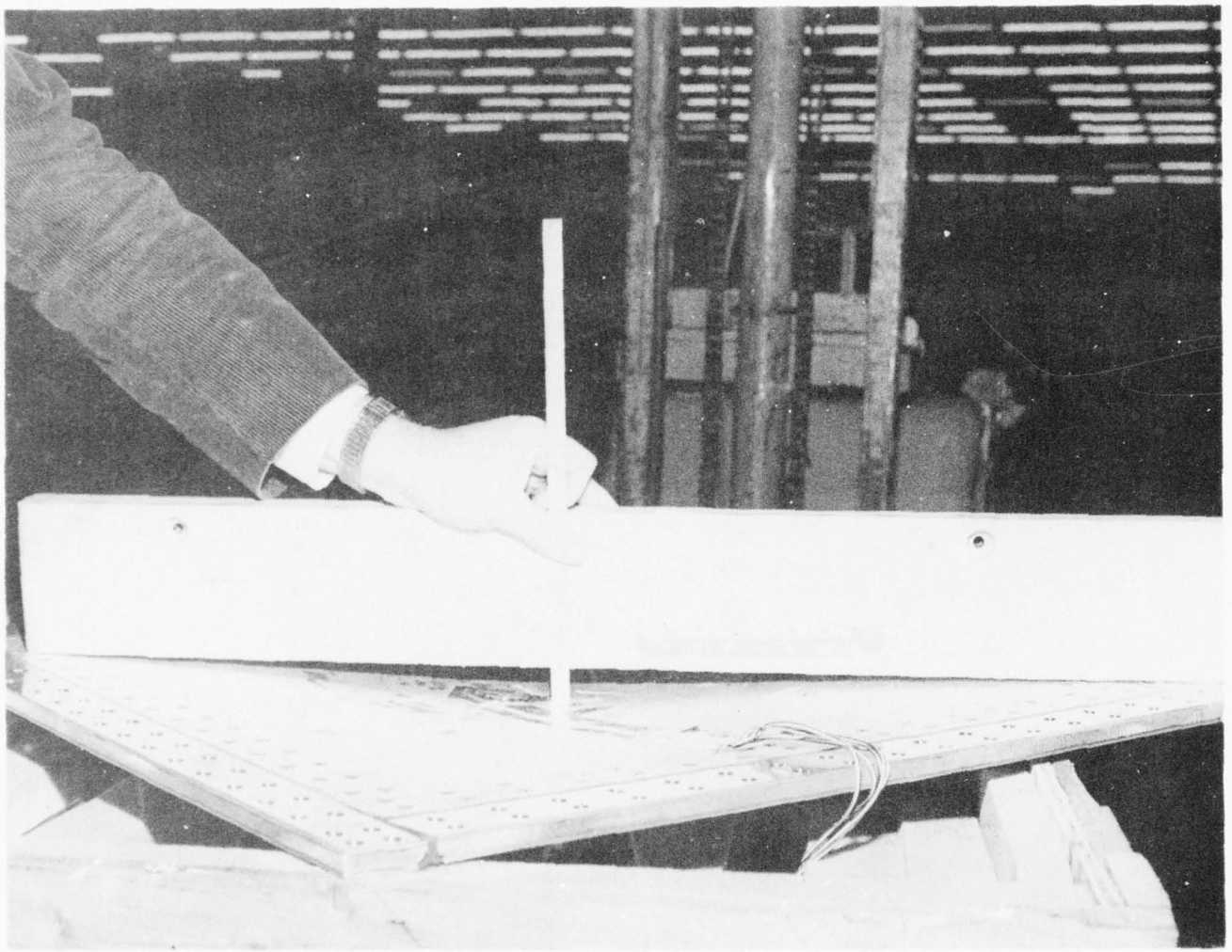


FIGURE 8-2 - SPECIMEN NO. 8 - INDICATION OF SHOCK TEST PERMANENT DEFORMATION

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO. 1 - STATIC ANALYSIS - ITEX-FIX TWO SPECIES                    1
          1         0                                                           2
5000.      0.001     0.02      0.0                                             3
0.0        0.0       0.0       0.0                                             4
        15        15                                                           5
500.                                                                           7
                                                                               8
          2         9                                                          9
          0         1                                                          10
0.5                                                                            11
          0         0                                                          12
          0         0                                                          13
          2         2                                                          14
48.0       0.0                                                                 15
20.0      -20.0                                                                16
-50.0      0.0                                                                 17
-70.0     -30.0                                                                18
          3                                                                    19
          4         3         1                                                20
-21.0      0.0      -11.0                                                      21
                                                                               22
          3                   14        11                                     1
          3         2         4                                              2
         10                                                                    3
          2         5                                                         4
          2         7                                                         4
          3         1                                                         4
          4         4                                                         5
          4         3                                                         4
          5         2                                                         4
          5         3                                                         4
          5         4                                                         4
          5         5                                                         4
          3                                                                   5
22.0       23.0                                                              5
0.013      0.0002539                                                         7
12300000.  12300000.   0.33      0.33      3550000.                          8
13270.     13270.                                                            9
0.305      1.214  E-05                                                       7
1.6        1.6         0.01      0.01      35500.                            8
1100.      1100.                                                             9
0.319      0.0002539                                                         7
12300000.  12300000.   0.33      0.33      3550000.                          8
13270.     13270.                                                            9
175000.    88000.      0.125                                                 10
0.0        0.0         0.0       0.0       0.0       0.0                     13
0.0        0.0         0.0       0.0       0.0       0.0                     13
0.0        0.0         0.0       0.0       0.0       0.0                     13
0.0        0.0         0.0       0.0       0.0       0.0                     13
0.0                                                                           13
0.0        0.001       0.0                                                    13
                                                                              32
```

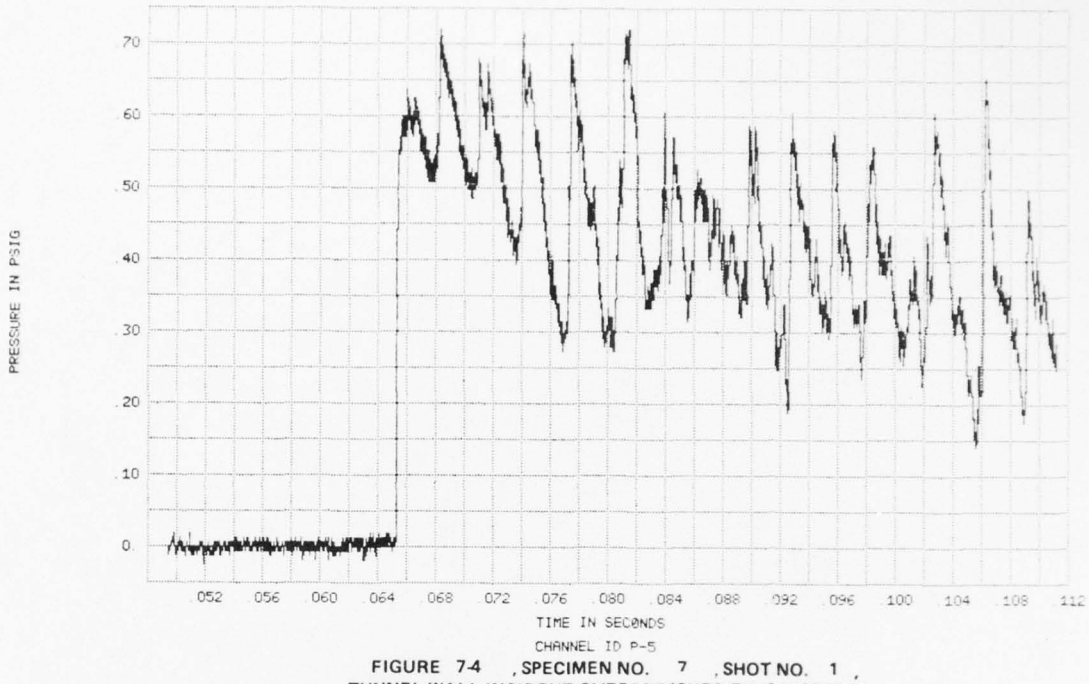


FIGURE 7-4 , SPECIMEN NO. 7 , SHOT NO. 1 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

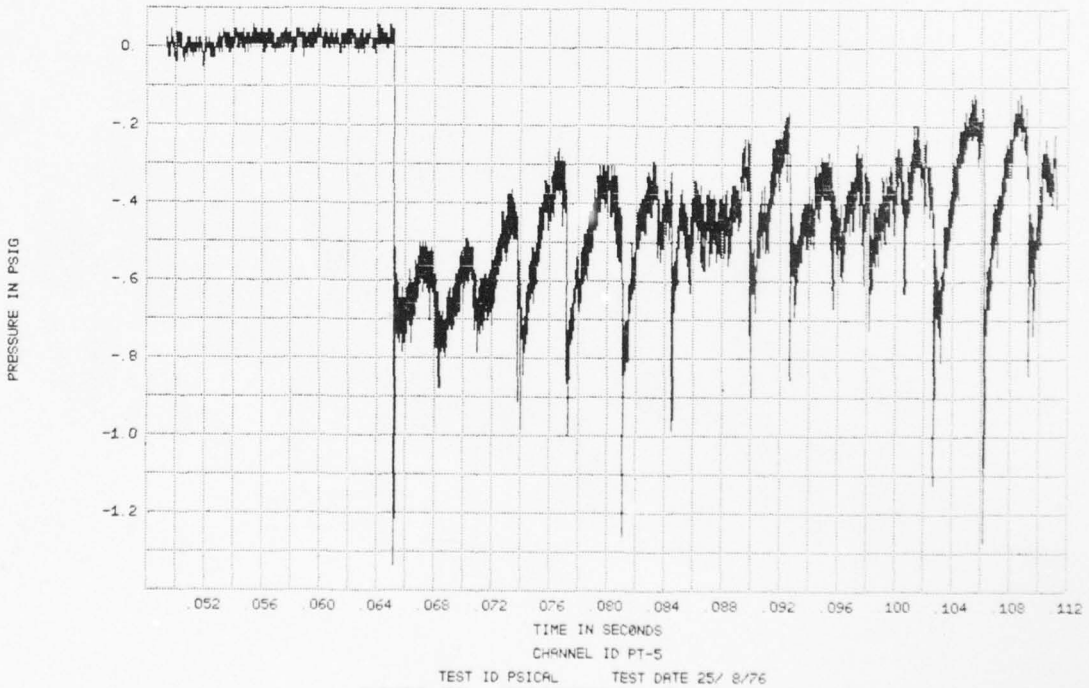


FIGURE 7-5 , SPECIMEN NO. 7 , SHOT NO. 1 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

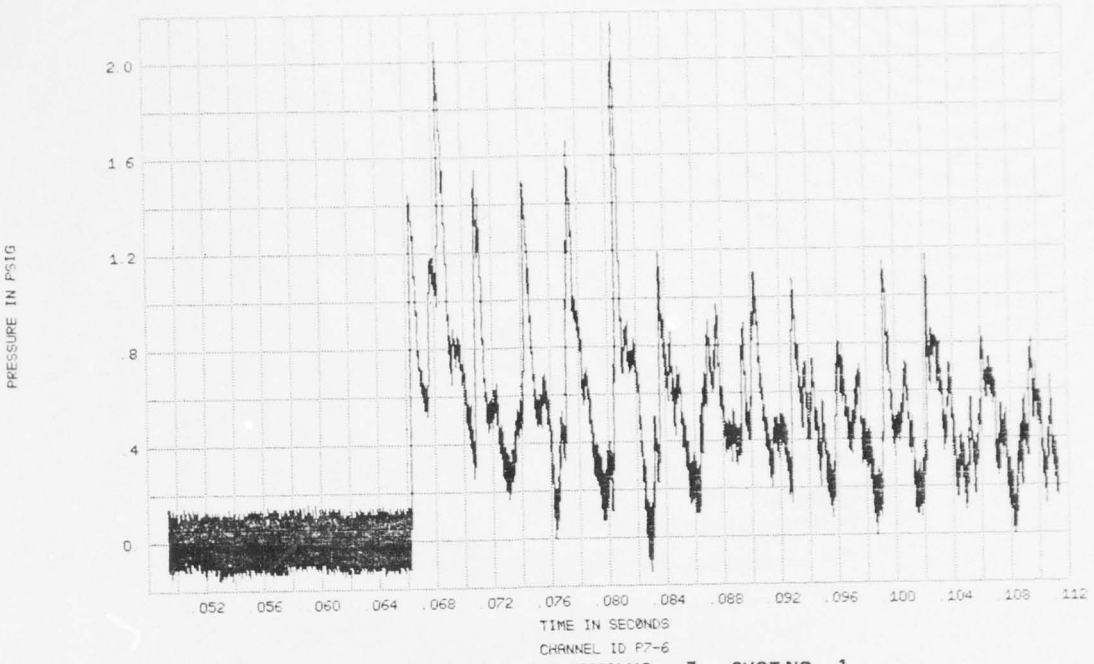


FIGURE 7-6 , SPECIMEN NO. 7 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

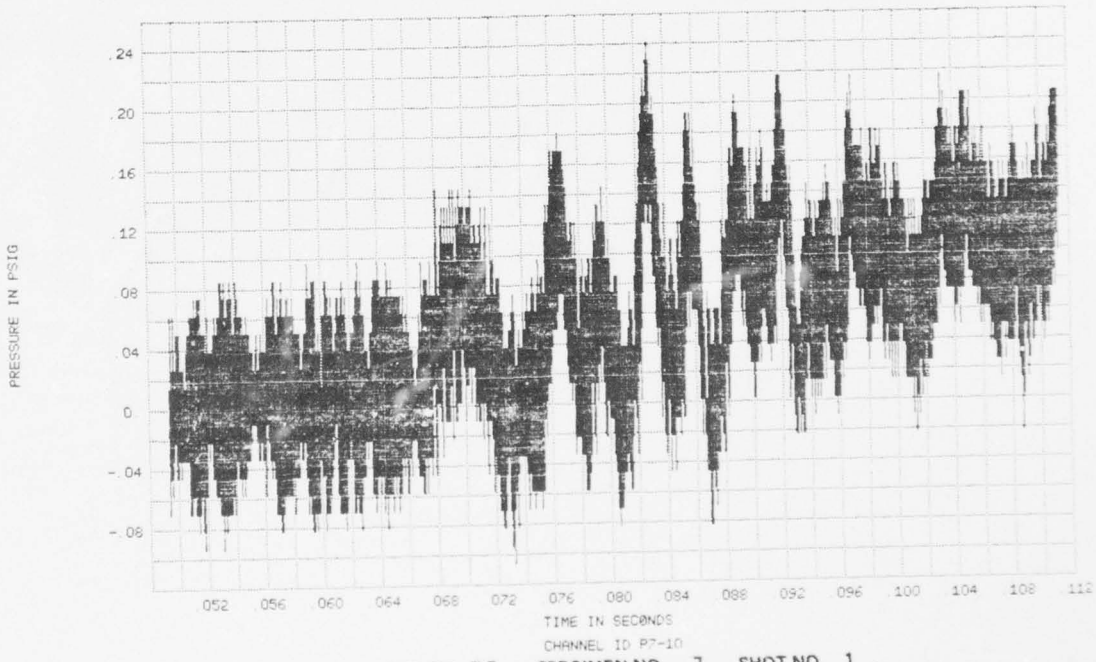


FIGURE 7-7 , SPECIMEN NO. 7 , SHOT NO. 1 ,
INTERNAL PRESSURE TIME HISTORY

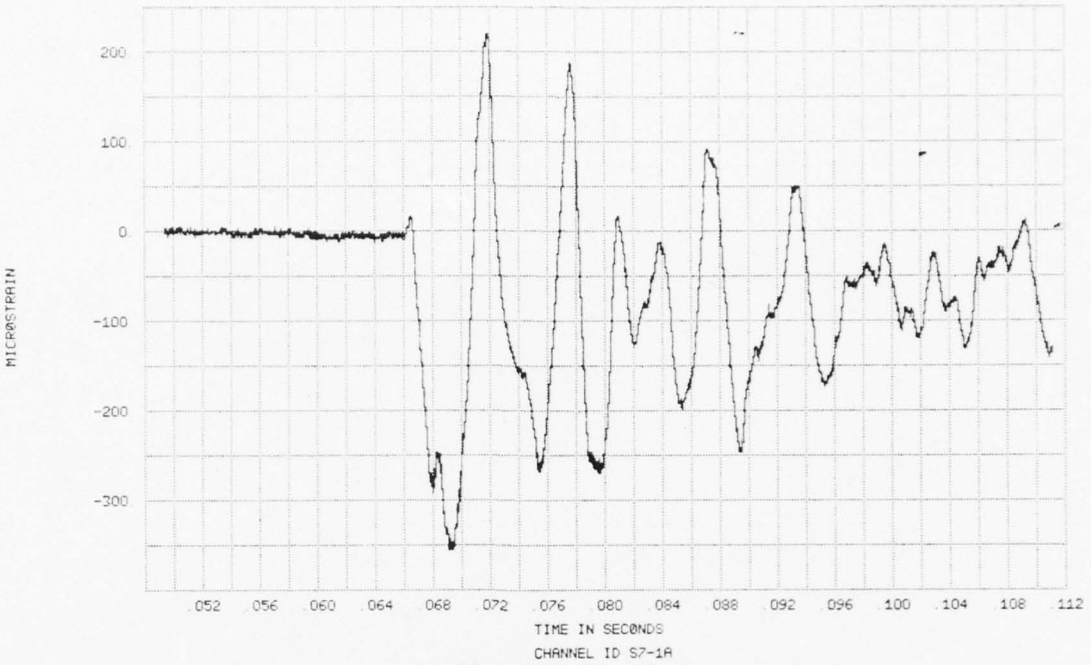


FIGURE 7-8 , SPECIMEN NO. 7 , SHOT NO. 1 ,
STRAIN TIME HISTORY

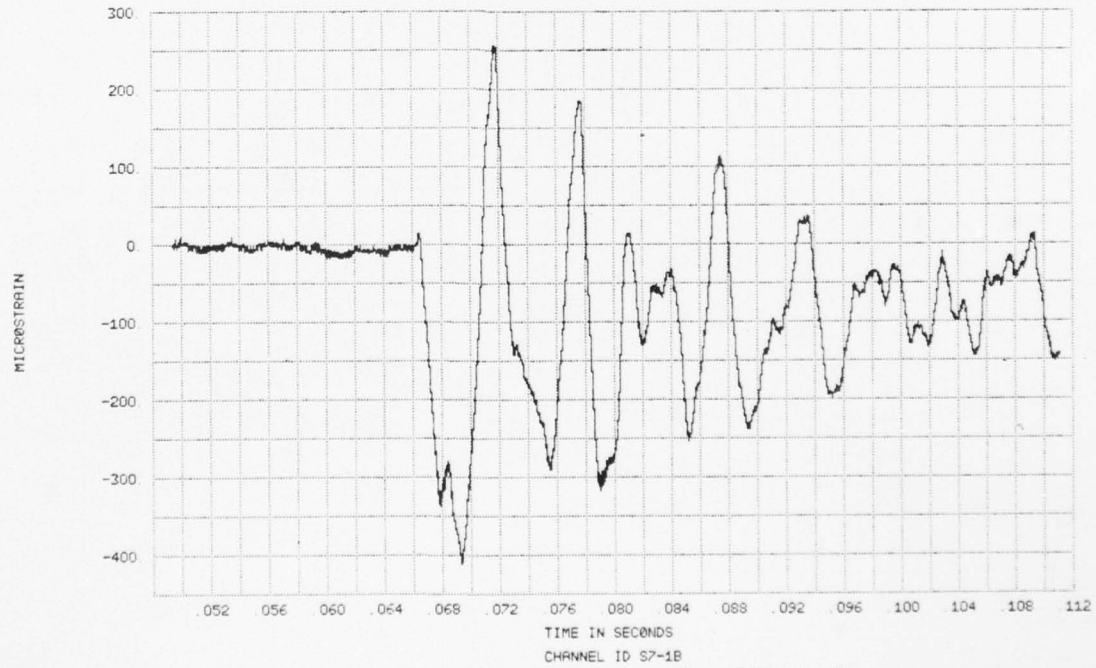


FIGURE 7-9 , SPECIMEN NO. 7 , SHOT NO. 1 ,
STRAIN TIME HISTORY

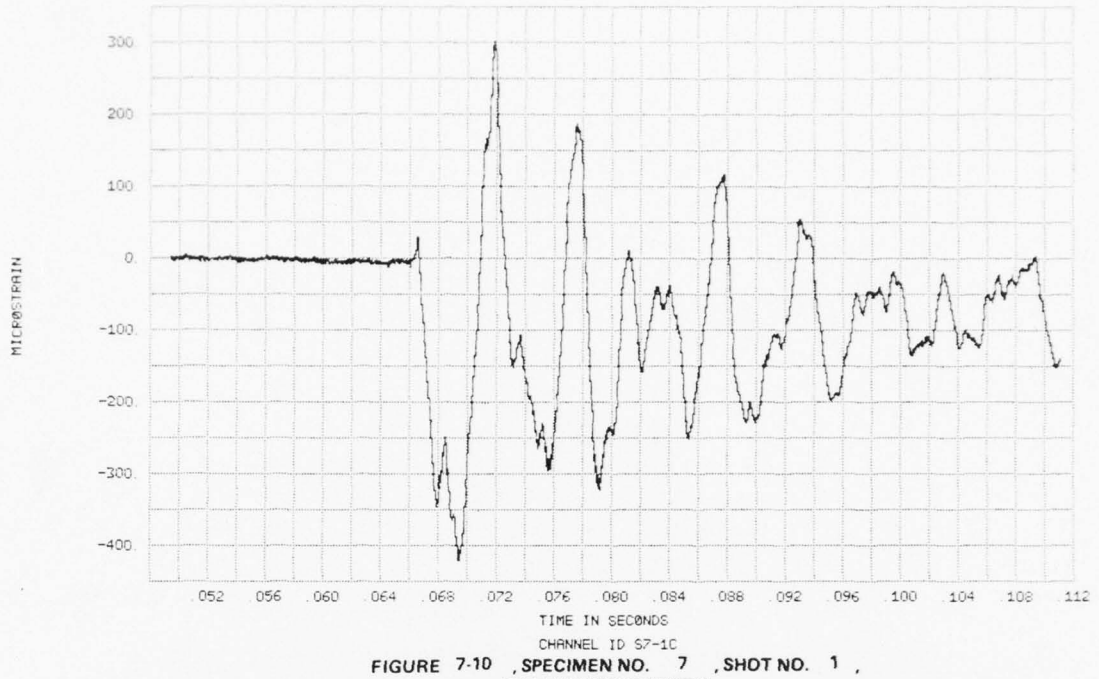


FIGURE 7-10 , SPECIMEN NO. 7 , SHOT NO. 1 , STRAIN TIME HISTORY

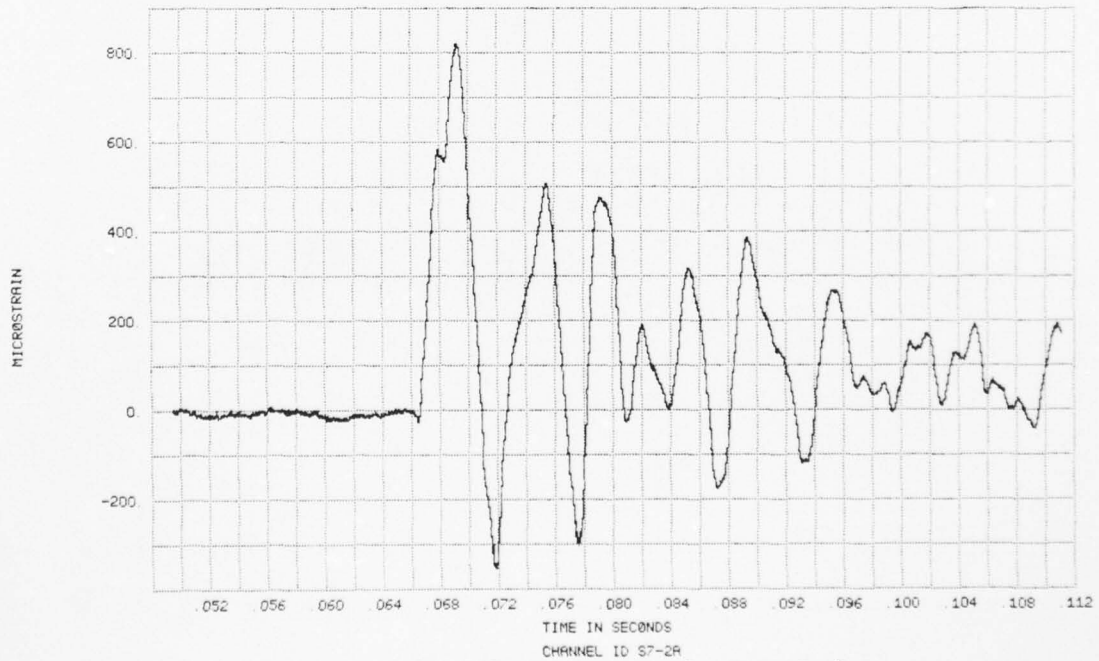


FIGURE 7-11 , SPECIMEN NO. 7 , SHOT NO. 1 , STRAIN TIME HISTORY

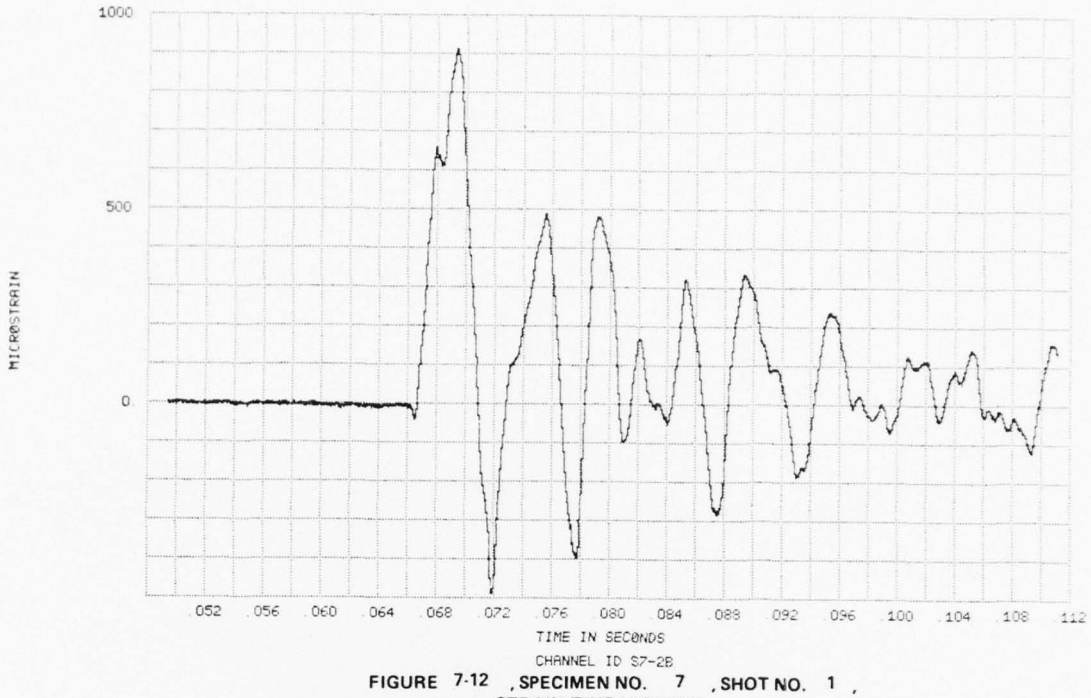


FIGURE 7-12 , SPECIMEN NO. 7 , SHOT NO. 1 ,
STRAIN TIME HISTORY

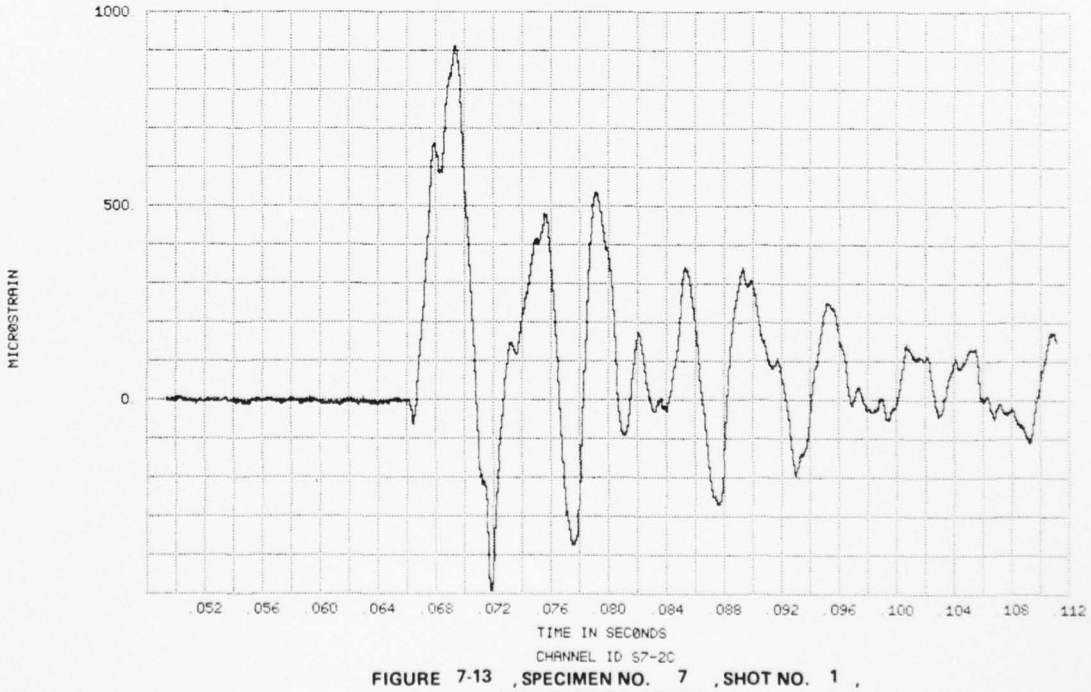


FIGURE 7-13 , SPECIMEN NO. 7 , SHOT NO. 1 ,
STRAIN TIME HISTORY

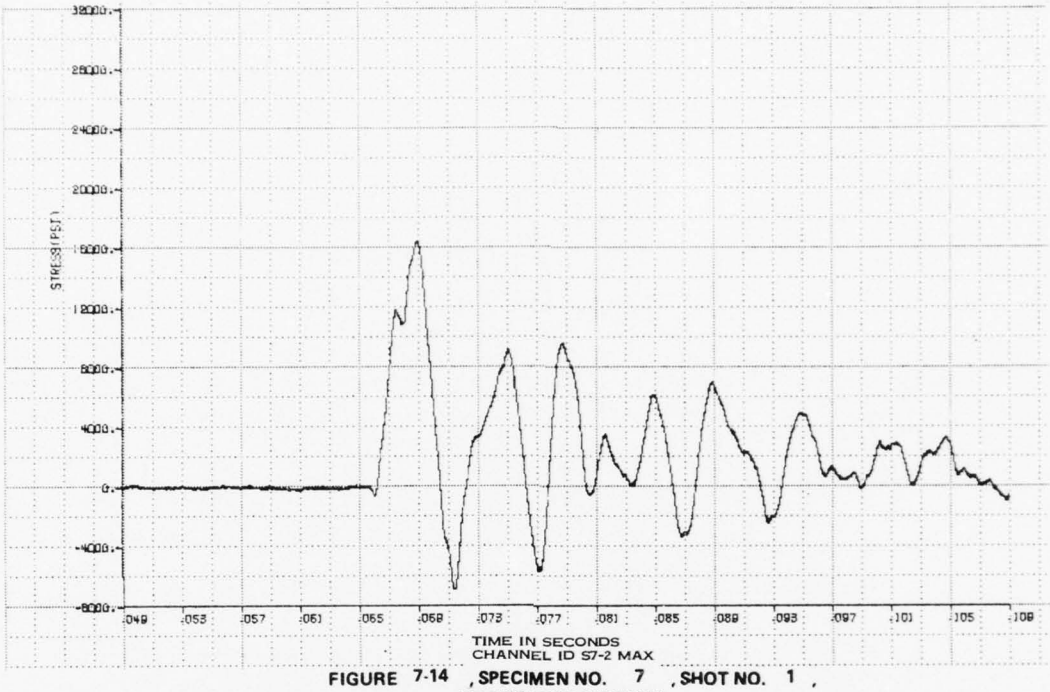


FIGURE 7-14 , SPECIMEN NO. 7 , SHOT NO. 1 ,
STRESS TIME HISTORY

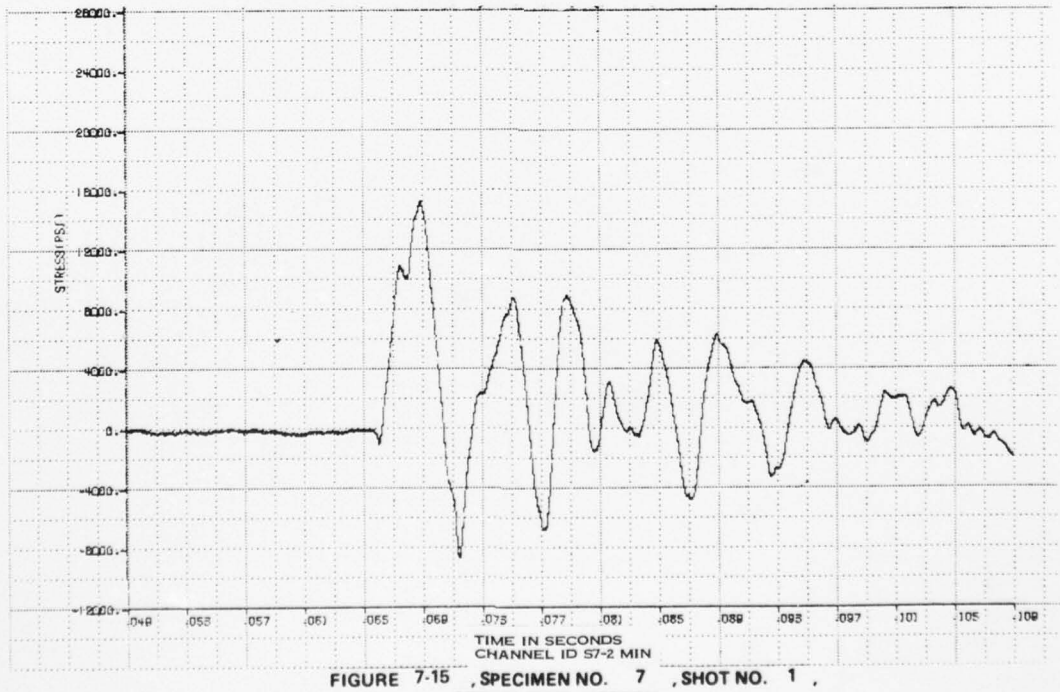


FIGURE 7-15 , SPECIMEN NO. 7 , SHOT NO. 1 ,
STRESS TIME HISTORY

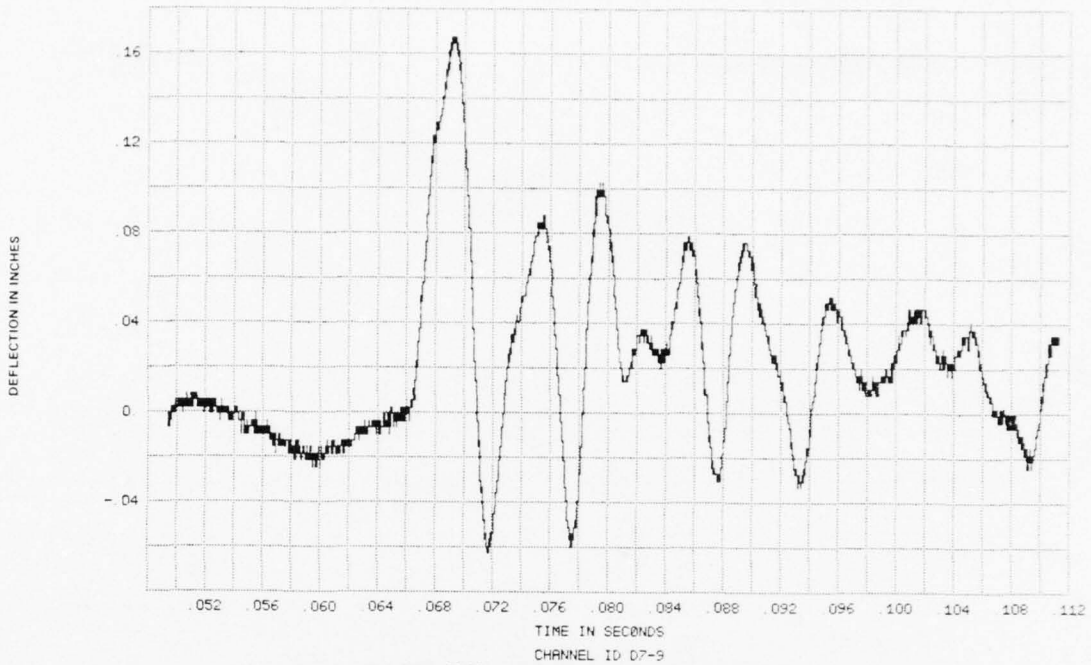


FIGURE 7-16 , SPECIMEN NO. 7 , SHOT NO. 1 ,
DEFLECTION TIME HISTORY

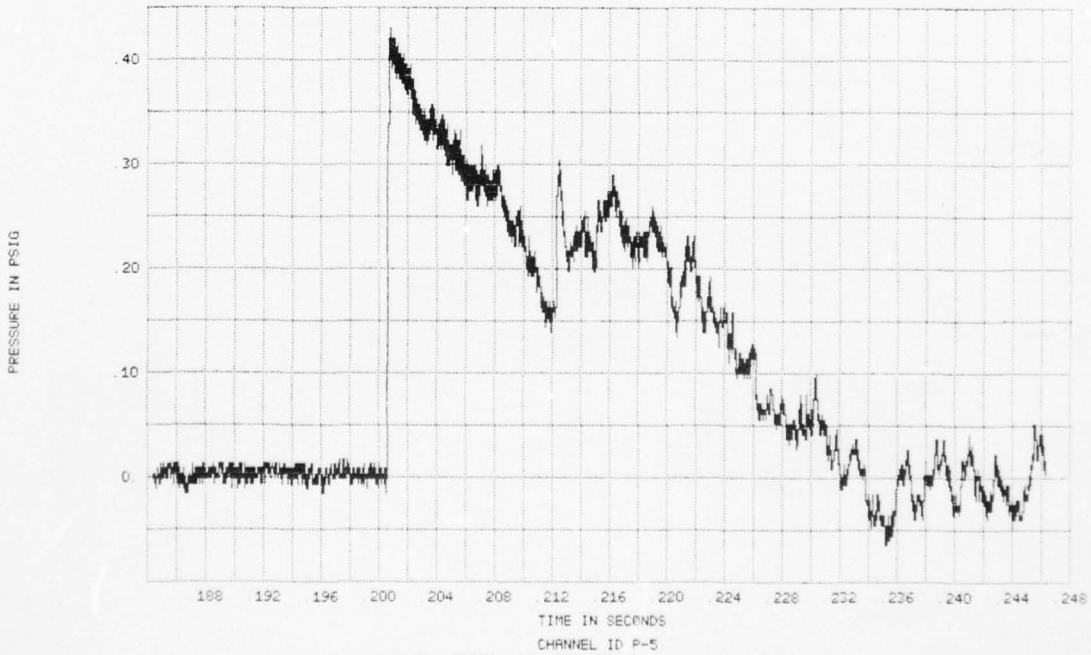


FIGURE 7-17 , SPECIMEN NO. 7 , SHOT NO. 2 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

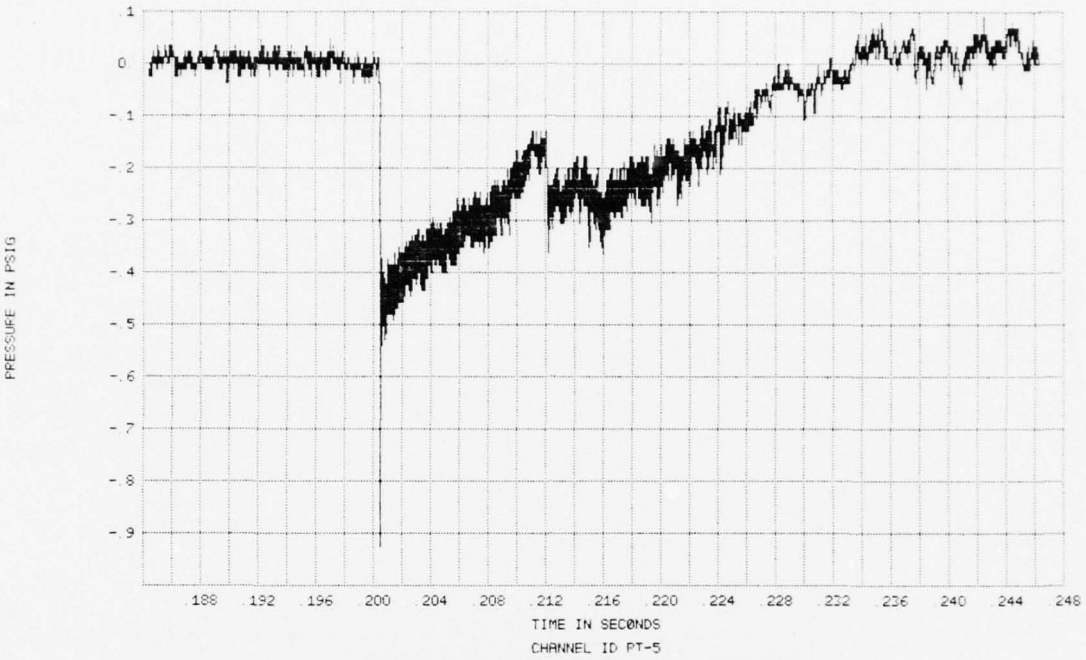


FIGURE 7-18 , SPECIMEN NO. 7 , SHOT NO. 2 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

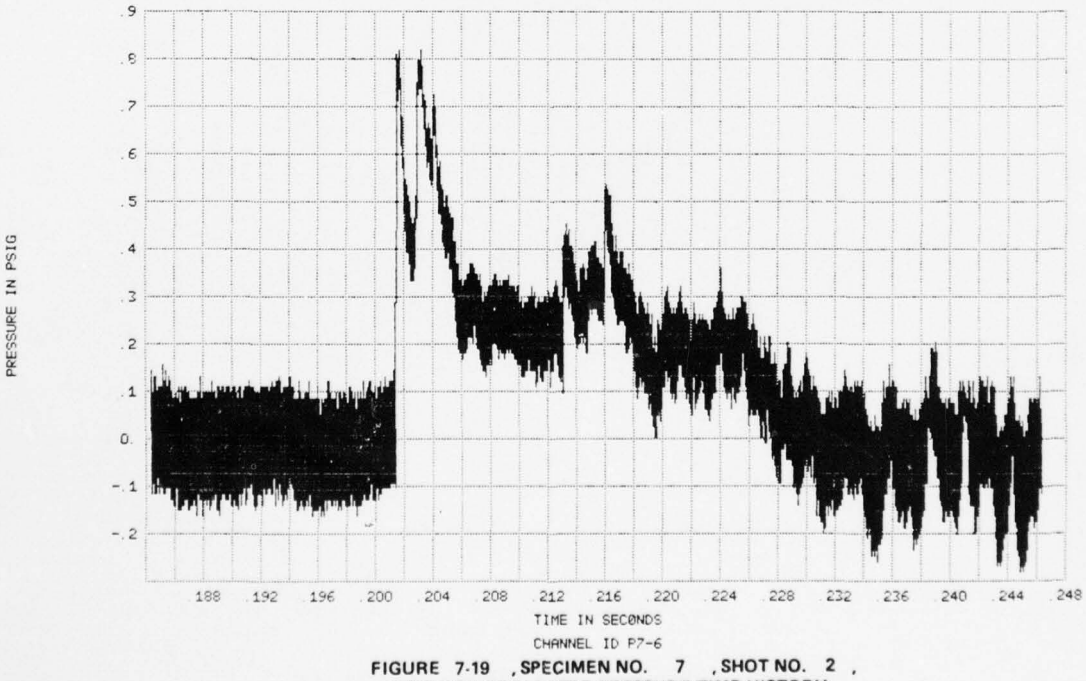


FIGURE 7-19 , SPECIMEN NO. 7 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

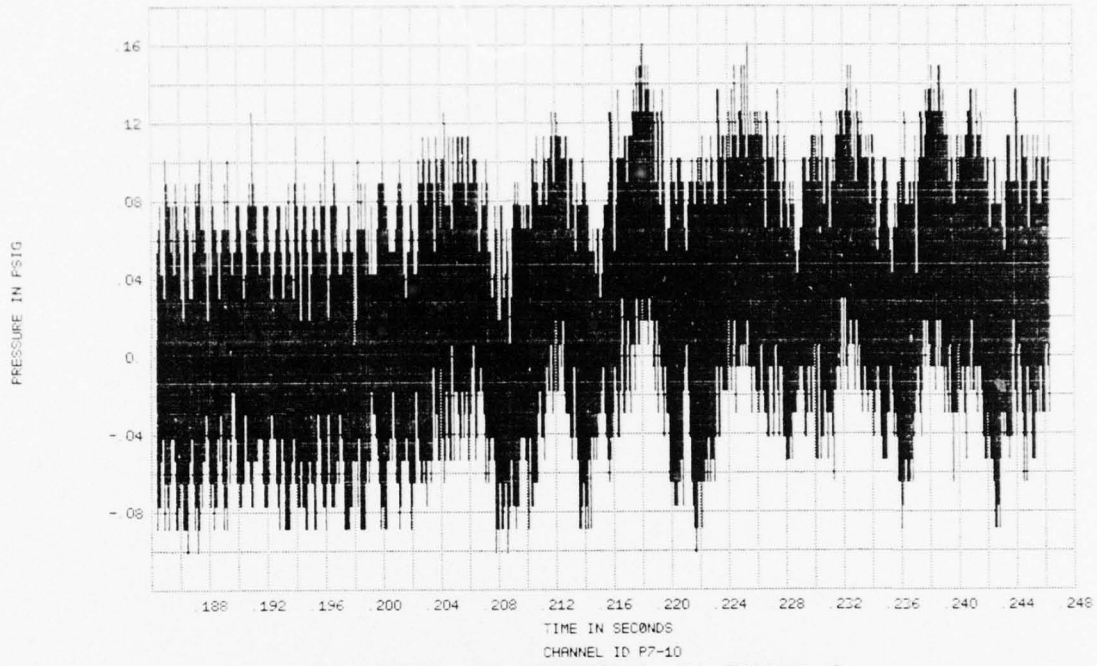


FIGURE 7-20 , SPECIMEN NO. 7 , SHOT NO. 2 ,
INTERNAL PRESSURE TIME HISTORY

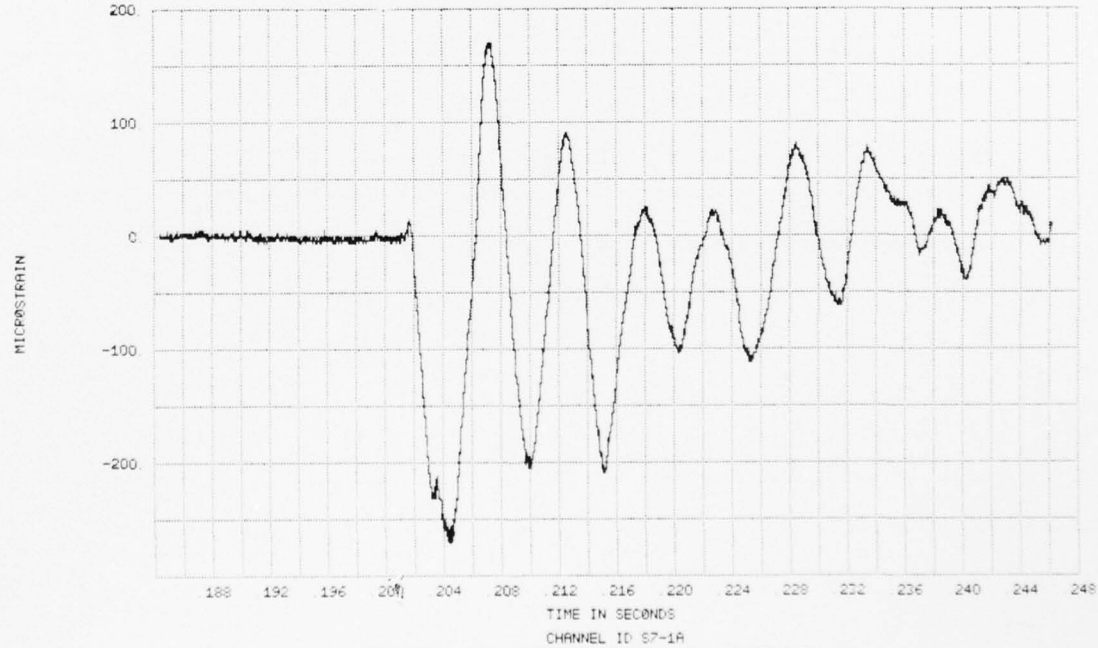


FIGURE 7-21 , SPECIMEN NO. 7 , SHOT NO. 2 ,
STRAIN TIME HISTORY

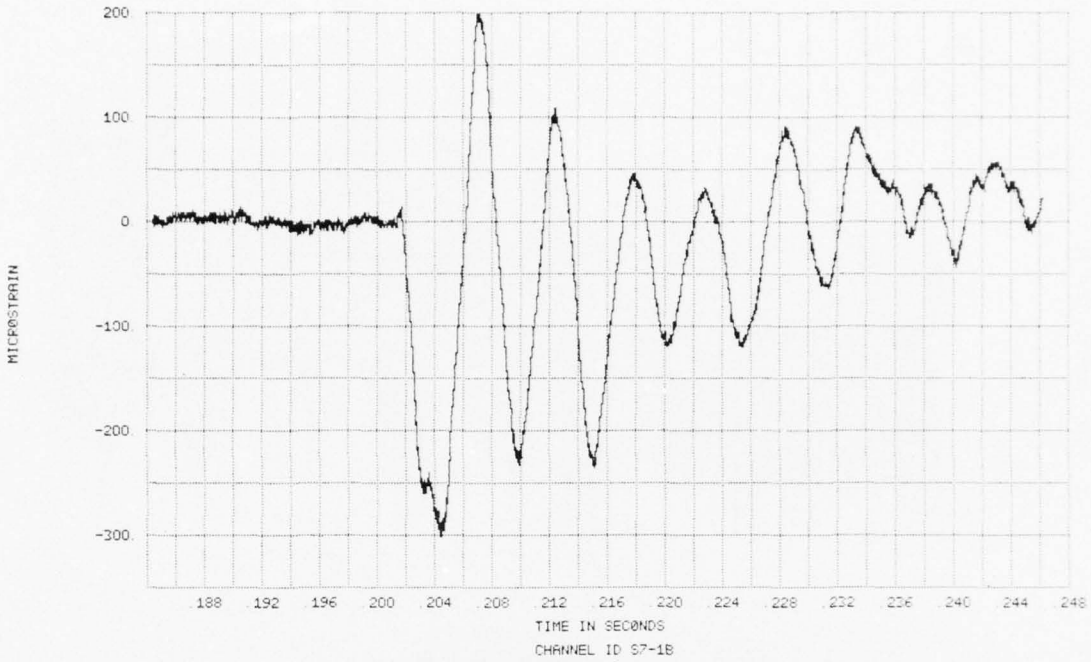


FIGURE 7-22 , SPECIMEN NO. 7 , SHOT NO. 2 ,
STRAIN TIME HISTORY

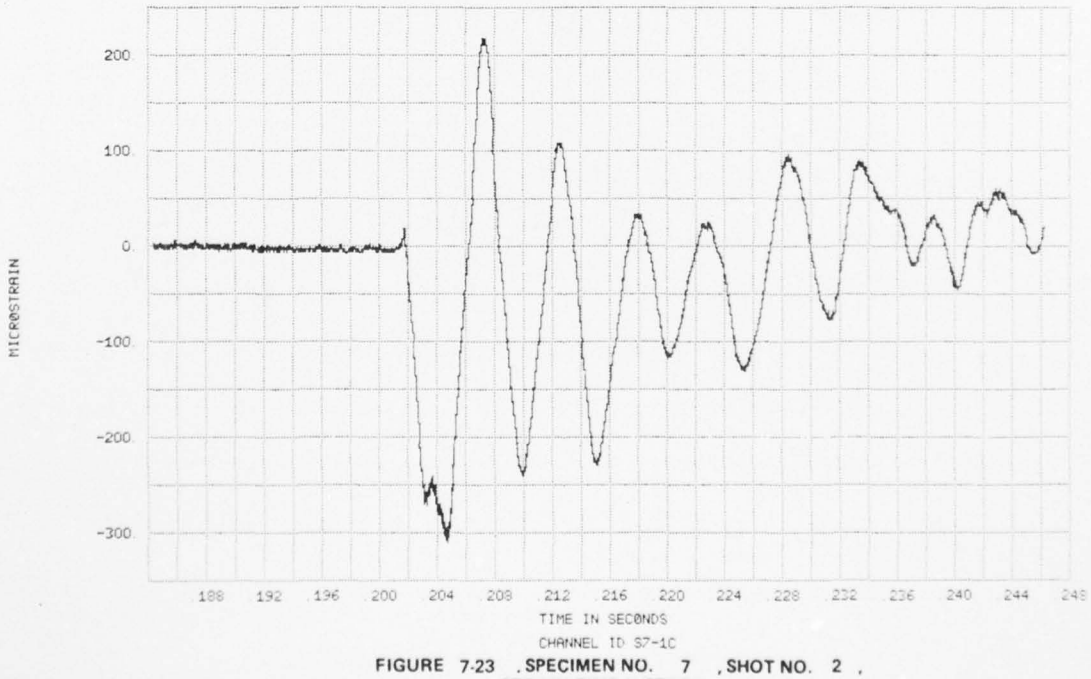


FIGURE 7-23 , SPECIMEN NO. 7 , SHOT NO. 2 ,
STRAIN TIME HISTORY

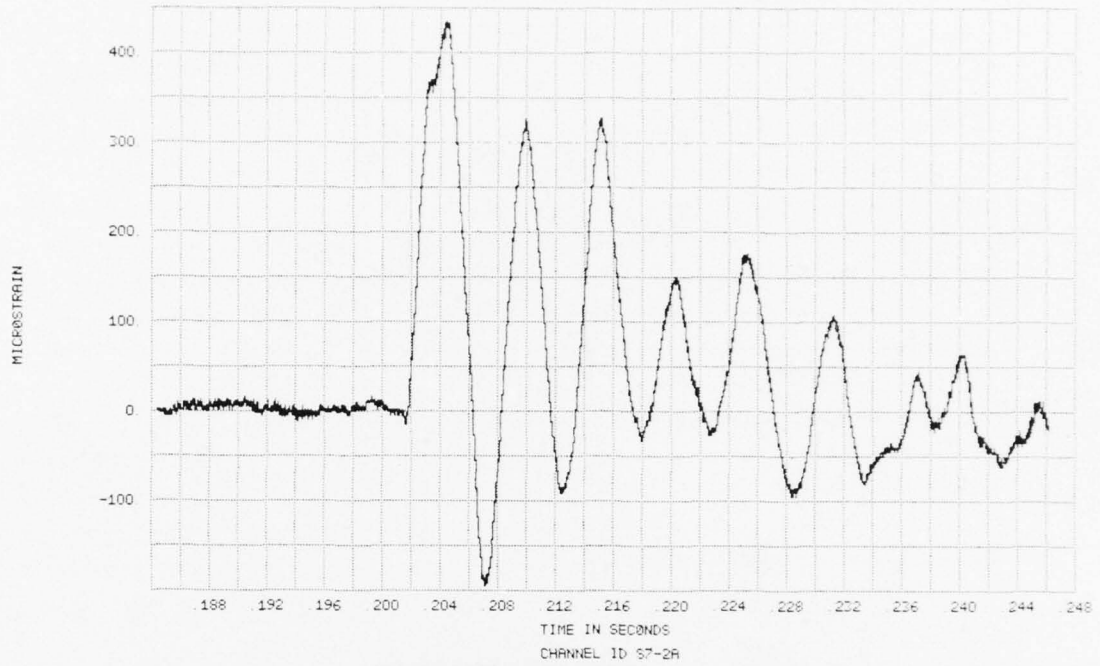


FIGURE 7-24 , SPECIMEN NO. 7 , SHOT NO. 2 , STRAIN TIME HISTORY

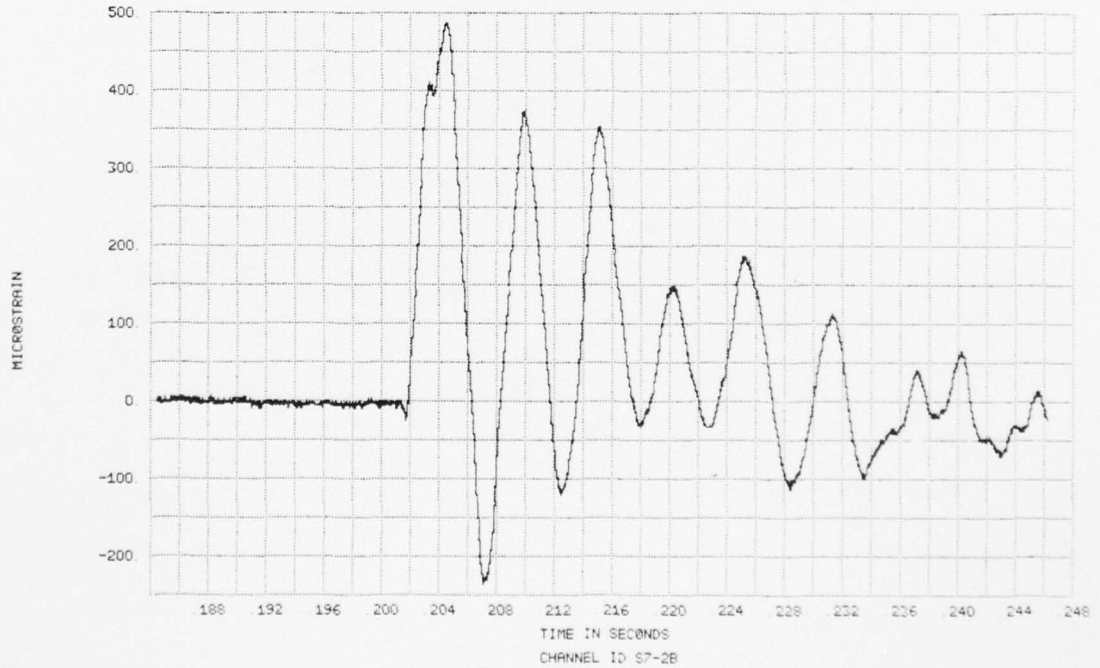


FIGURE 7-25 , SPECIMEN NO. 7 , SHOT NO. 2 , STRAIN TIME HISTORY

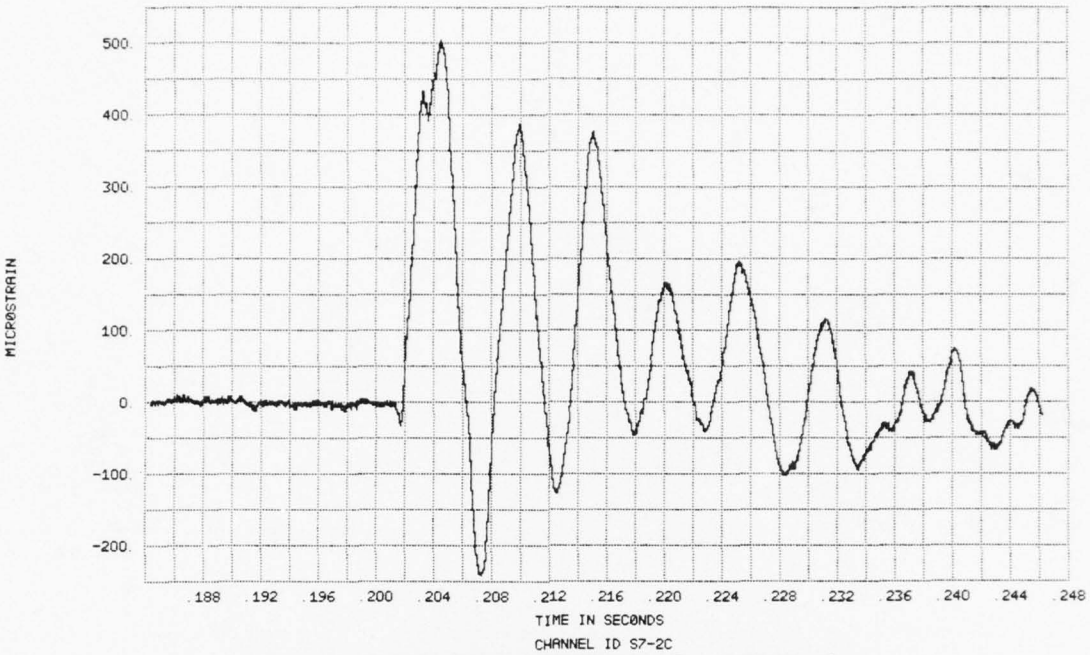


FIGURE 7-26 , SPECIMEN NO. 7 , SHOT NO. 2 , STRAIN TIME HISTORY

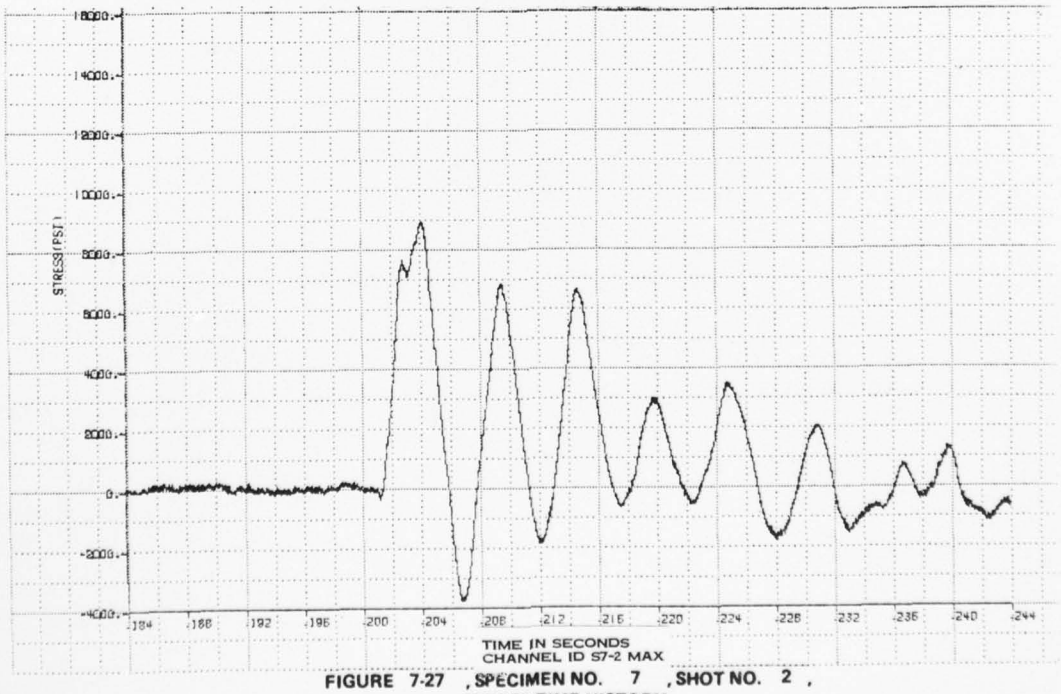


FIGURE 7-27 , SPECIMEN NO. 7 , SHOT NO. 2 , STRESS TIME HISTORY

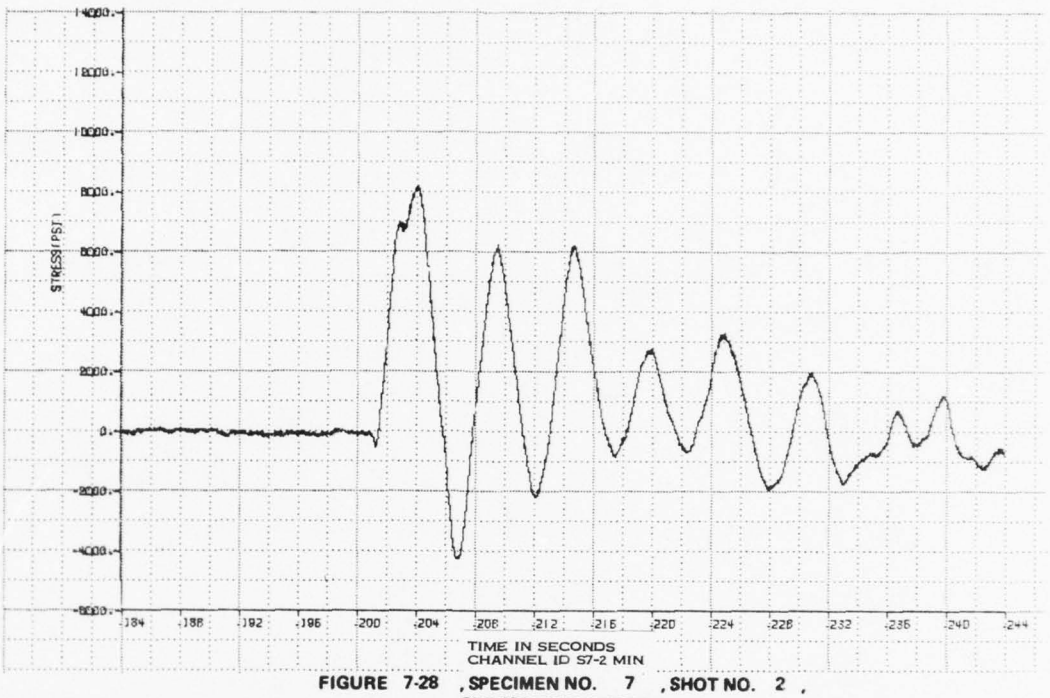


FIGURE 7-28 , SPECIMEN NO. 7 , SHOT NO. 2 , STRESS TIME HISTORY

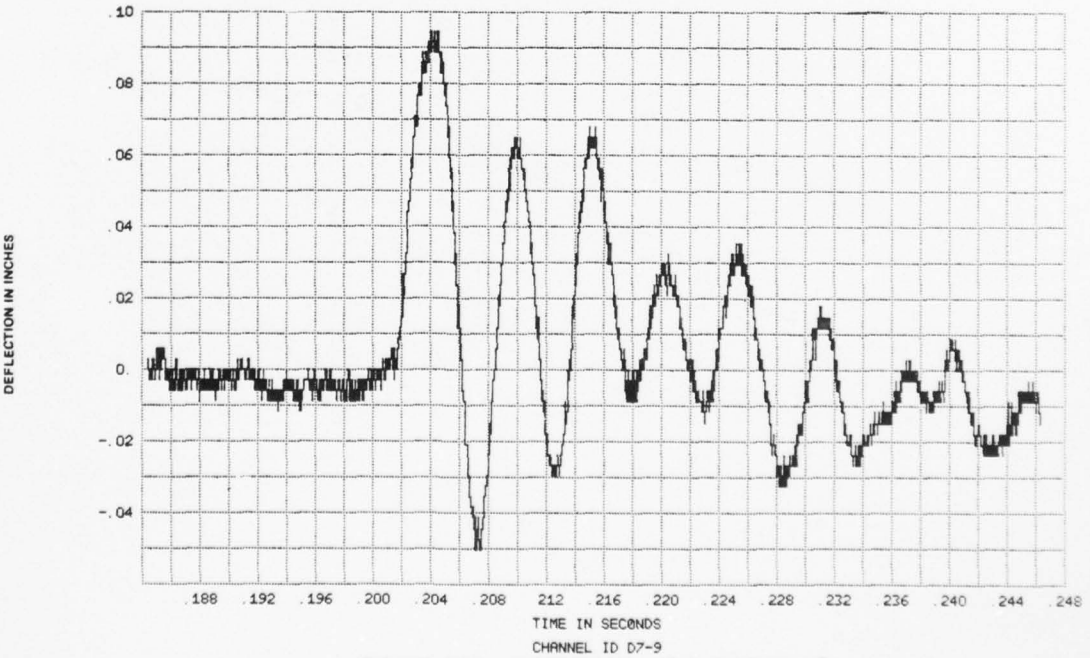


FIGURE 7-29 , SPECIMEN NO. 7 , SHOT NO. 2 , DEFLECTION TIME HISTORY

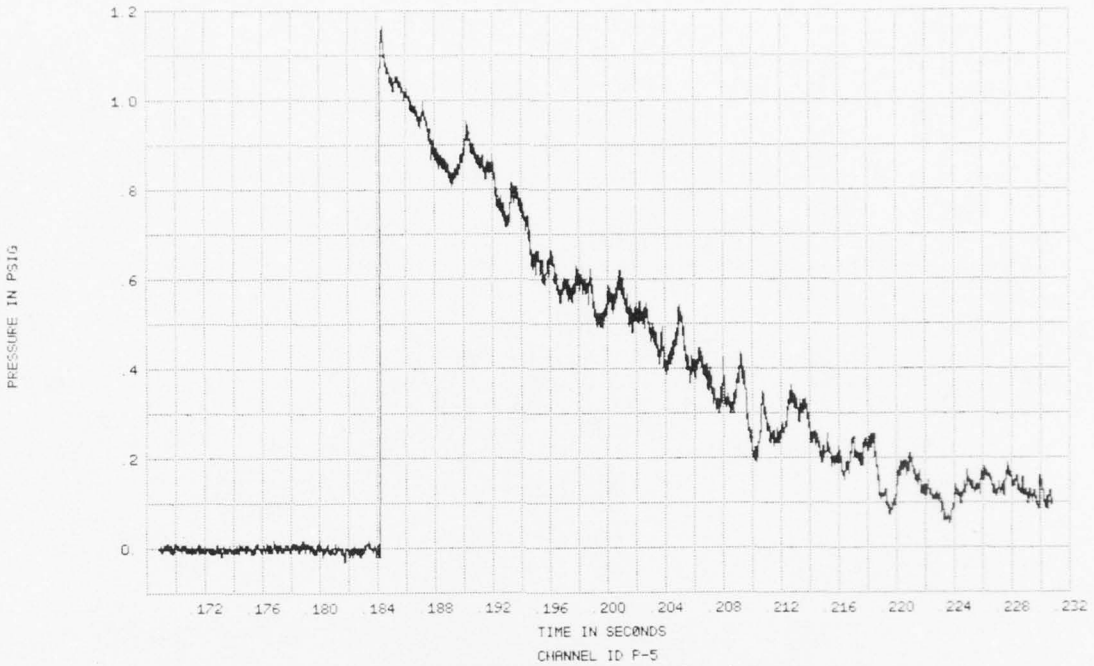


FIGURE 7-30 , SPECIMEN NO. 7 , SHOT NO. 3 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

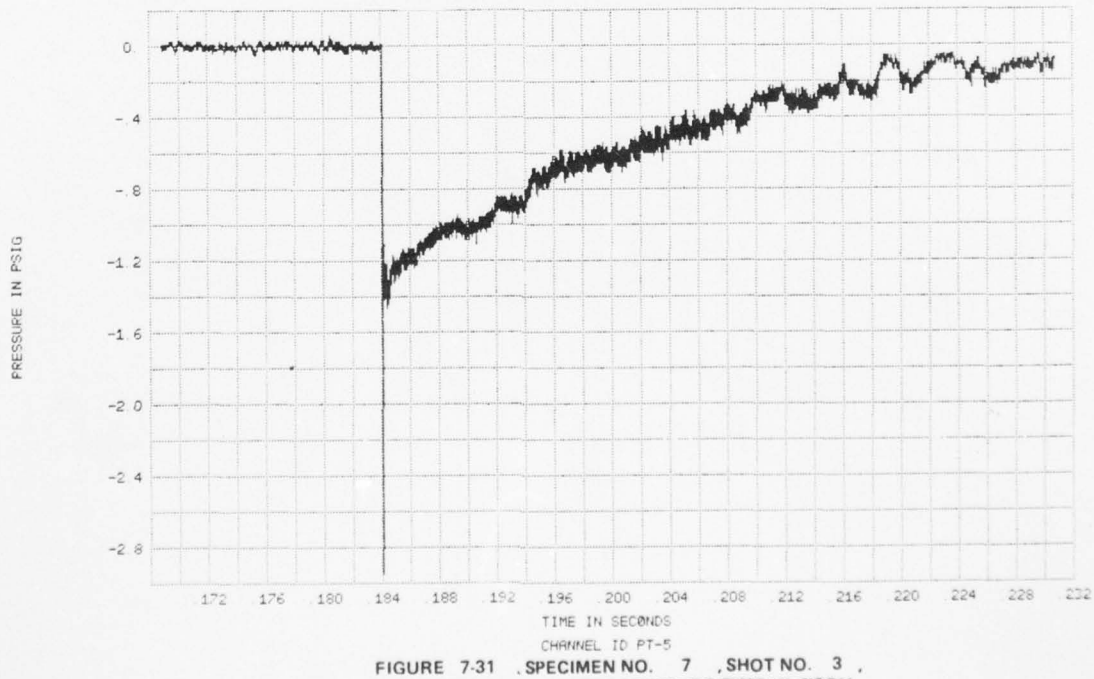


FIGURE 7-31 , SPECIMEN NO. 7 , SHOT NO. 3 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

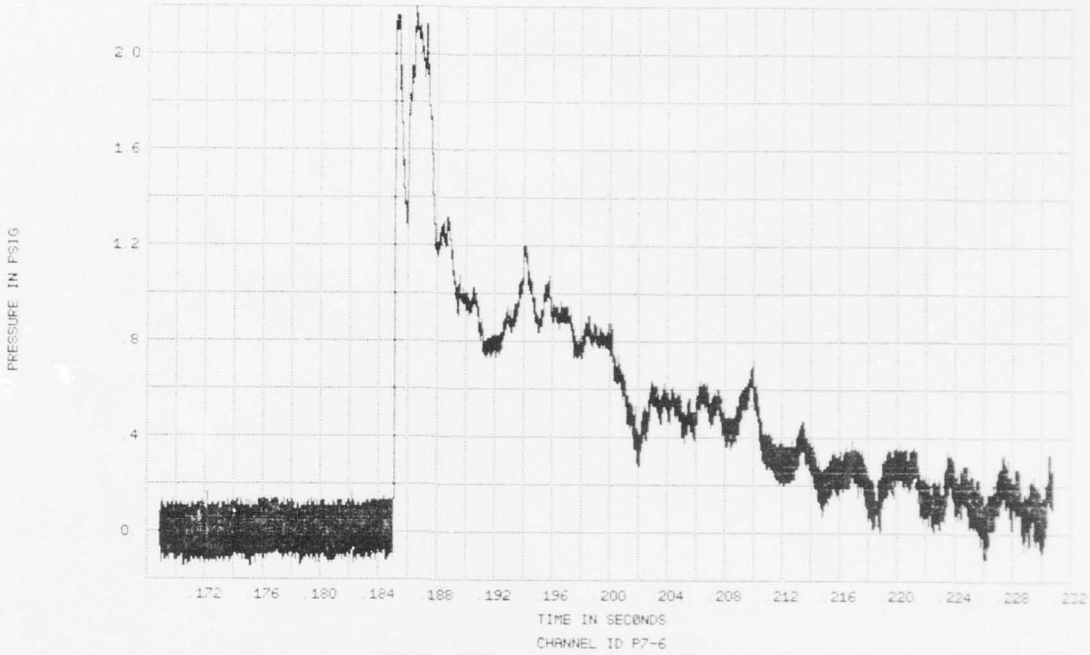


FIGURE 7-32 , SPECIMEN NO. 7 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

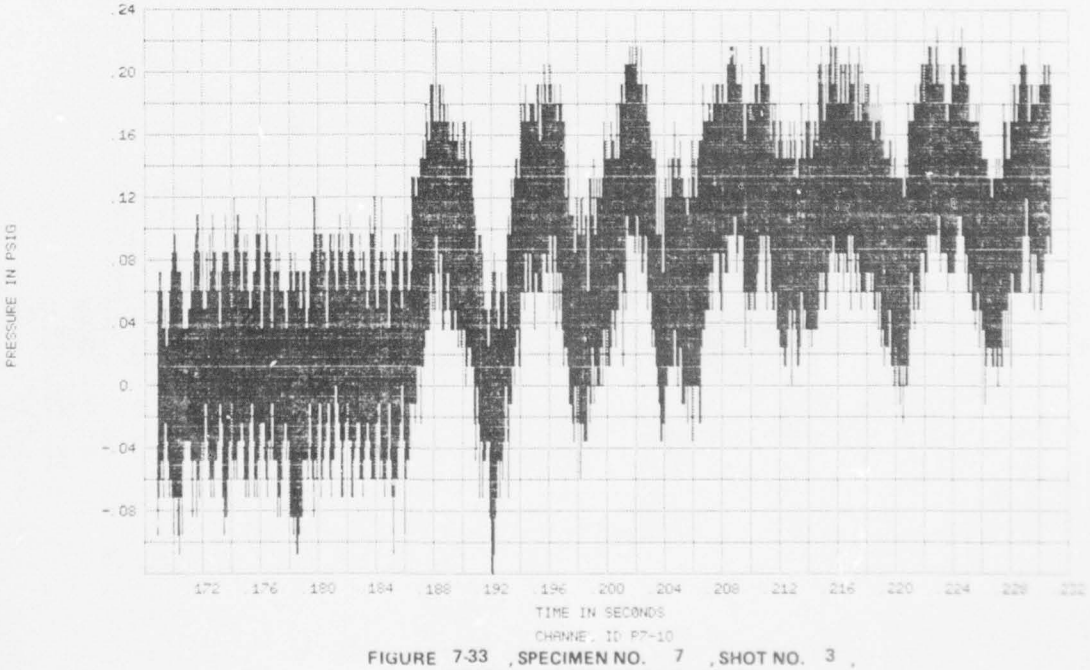
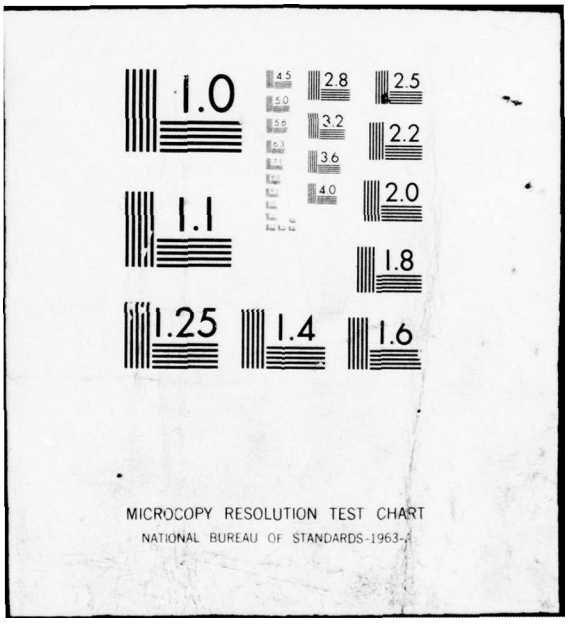


FIGURE 7-33 , SPECIMEN NO. 7 , SHOT NO. 3 ,
INTERNAL PRESSURE TIME HISTORY

AD-A052 029 BOEING WICHITA CO KS F/G 18/3
STRUCTURAL RESPONSE TO SIMULATED NUCLEAR OVERPRESSURE (STRESNO)--ETC(U)
MAR 77 R P SYRING, W D PIERSON DNA001-76-C-0084
UNCLASSIFIED D3-9788-5-VOL-2 DNA-4278F-2 NL

5 OF 8
AD A052 029




1.0
1.1
1.25
1.4
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

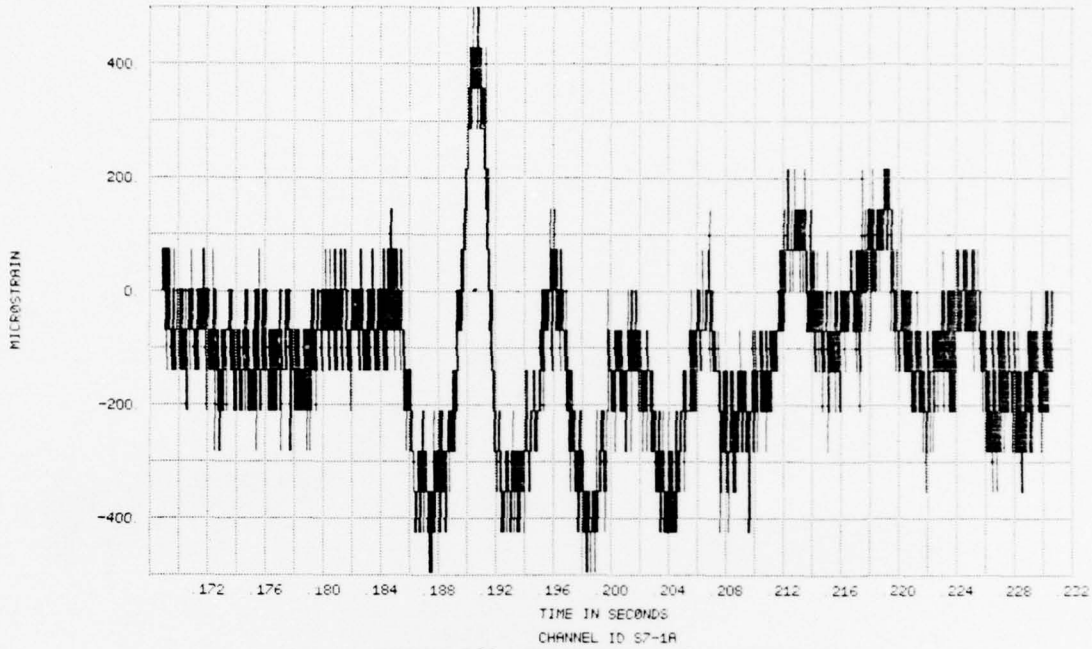


FIGURE 7-34 , SPECIMEN NO. 7 , SHOT NO. 3 , STRAIN TIME HISTORY

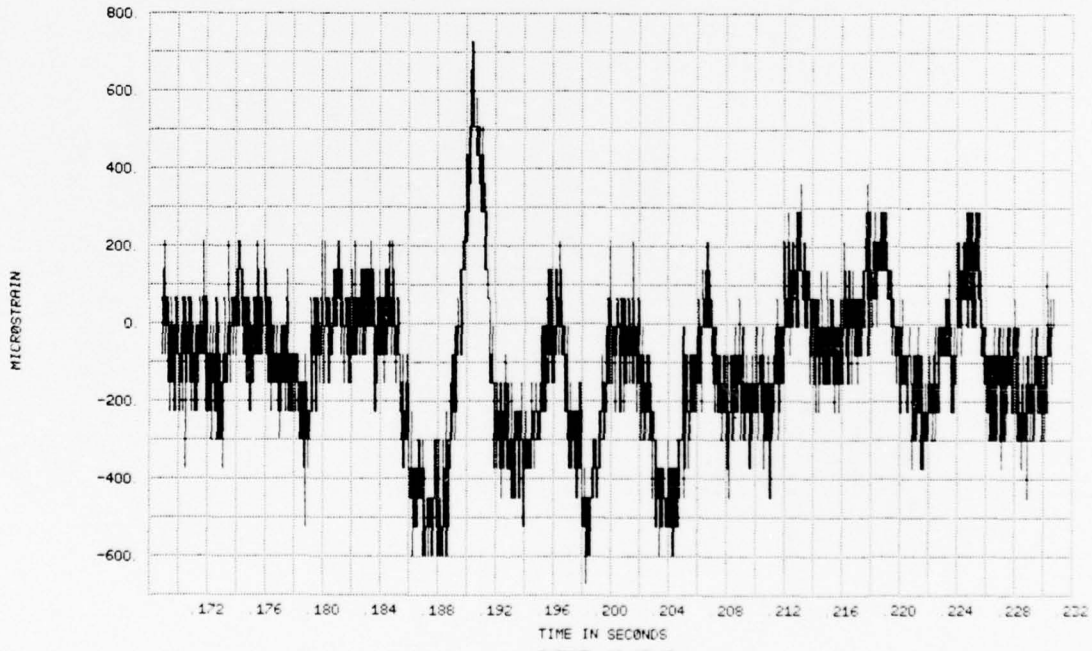


FIGURE 7-35 , SPECIMEN NO. 7 , SHOT NO. 3 , STRAIN TIME HISTORY

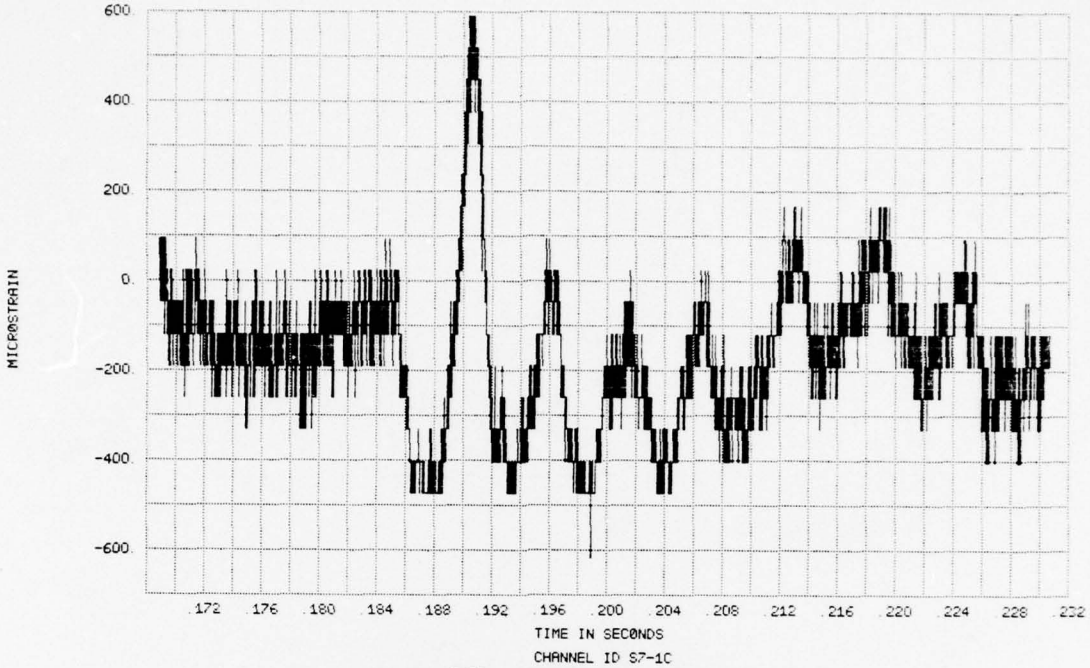


FIGURE 7-36 , SPECIMEN NO. 7 , SHOT NO. 3 , STRAIN TIME HISTORY

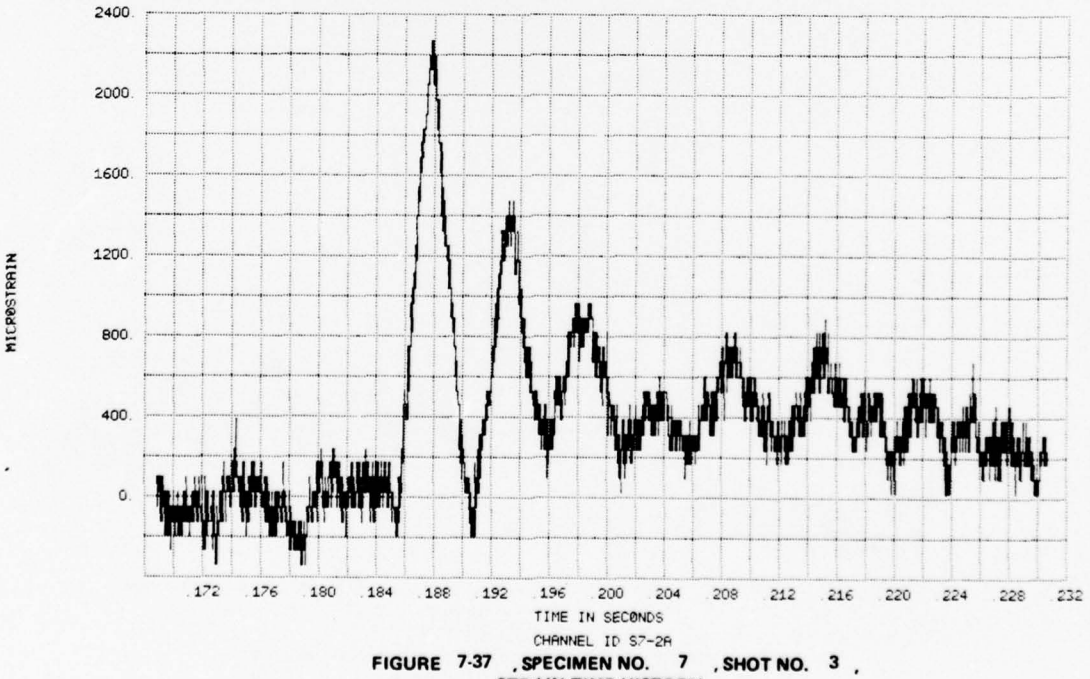


FIGURE 7-37 , SPECIMEN NO. 7 , SHOT NO. 3 , STRAIN TIME HISTORY

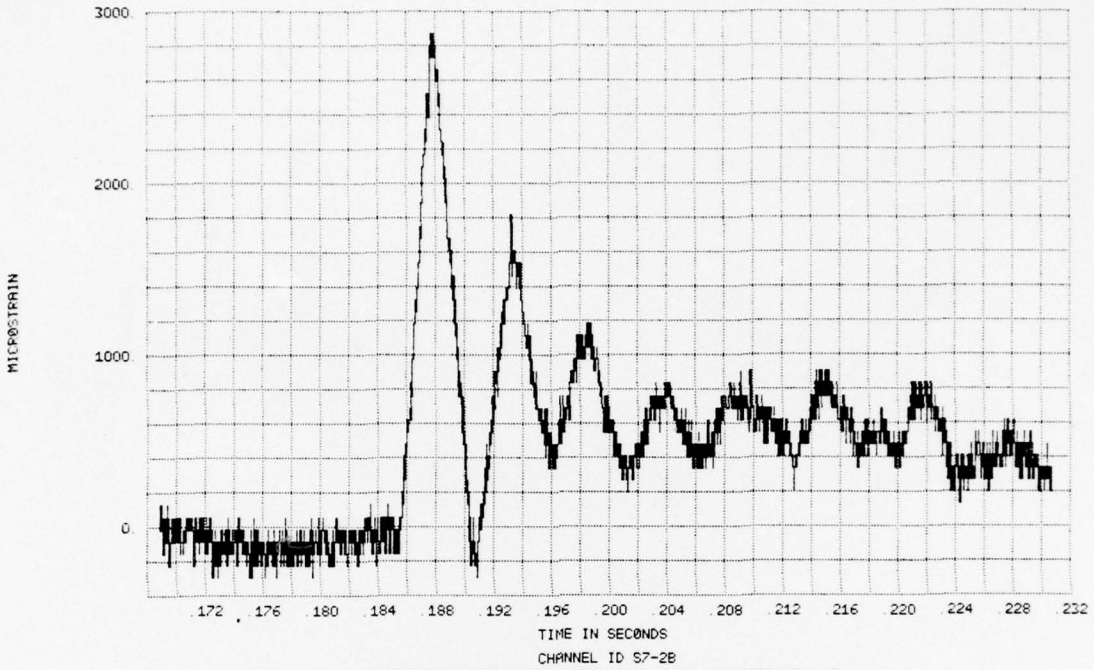


FIGURE 7-38 , SPECIMEN NO. 7 , SHOT NO. 3 , STRAIN TIME HISTORY

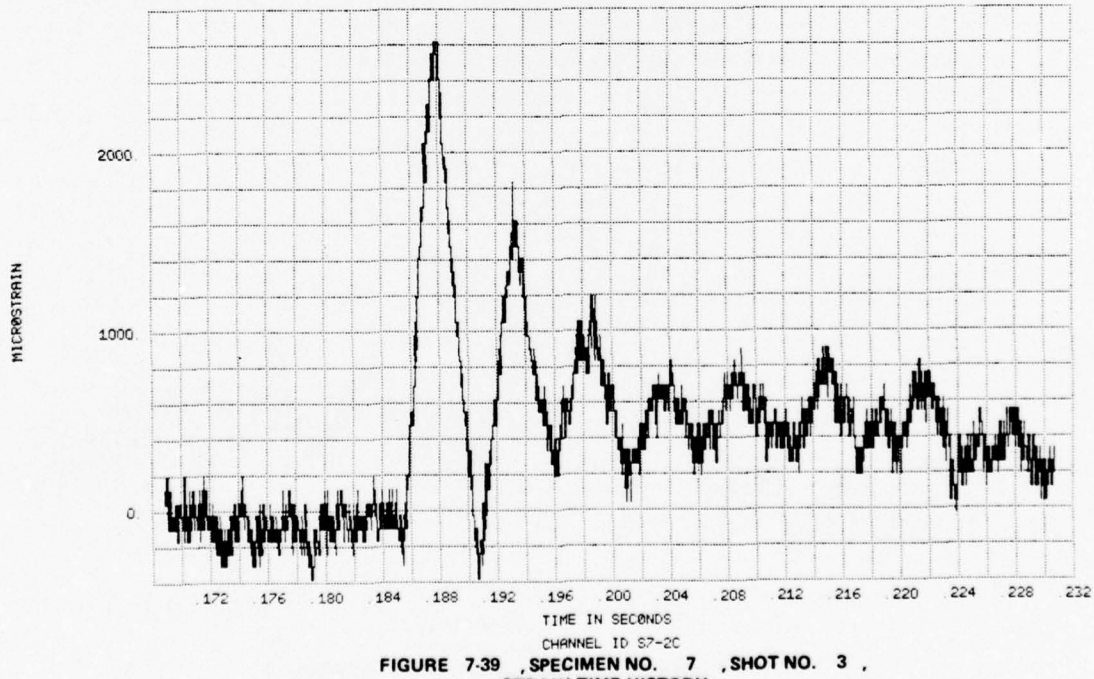


FIGURE 7-39 , SPECIMEN NO. 7 , SHOT NO. 3 , STRAIN TIME HISTORY

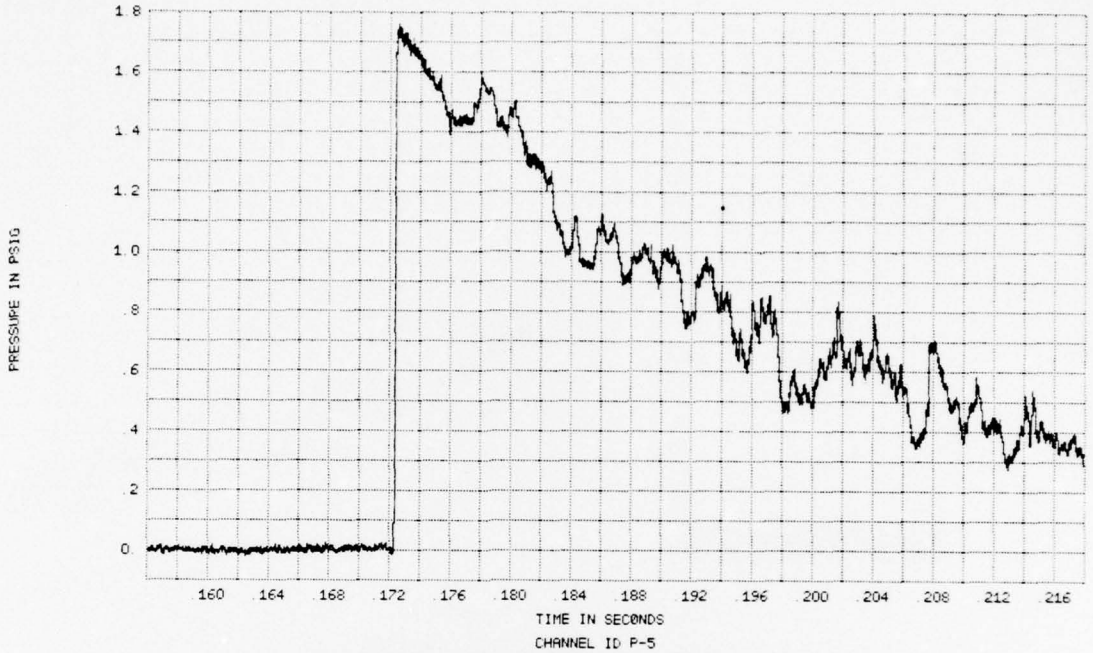


FIGURE 7-40 , SPECIMEN NO. 7 , SHOT NO. 4 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

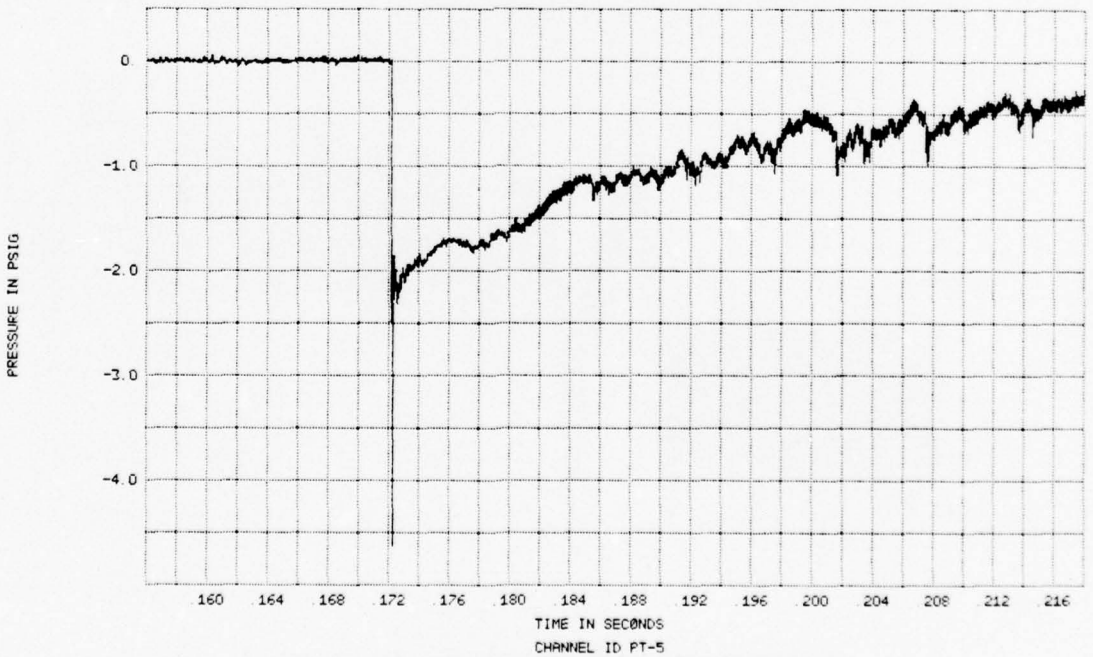


FIGURE 7-41 , SPECIMEN NO. 7 , SHOT NO. 4 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

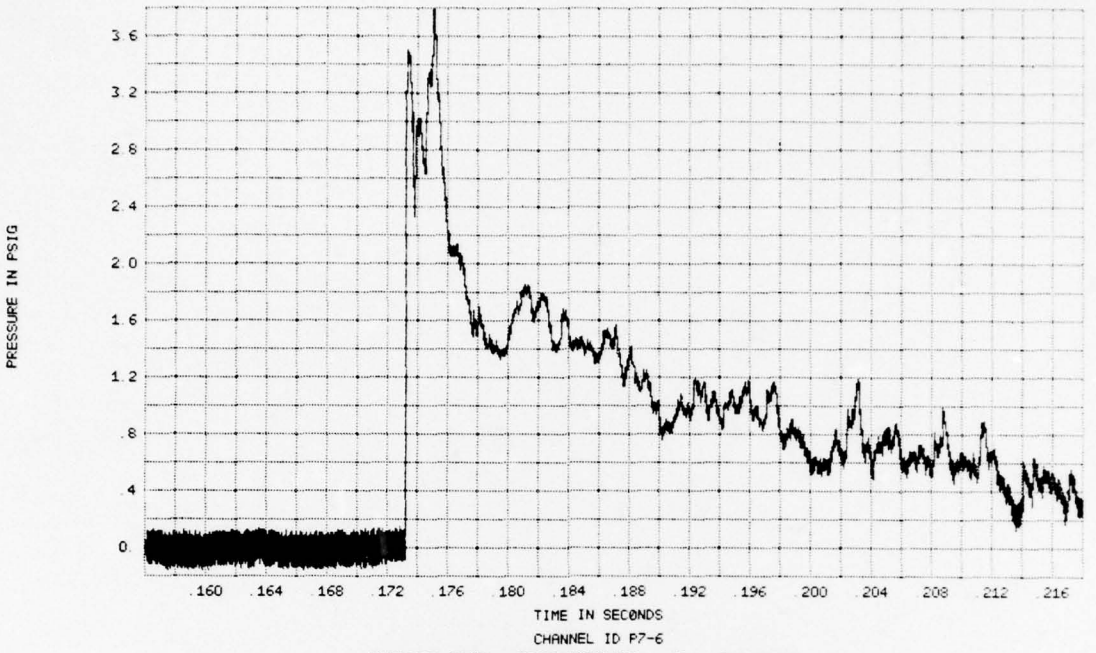


FIGURE 7-42 , SPECIMEN NO. 7 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

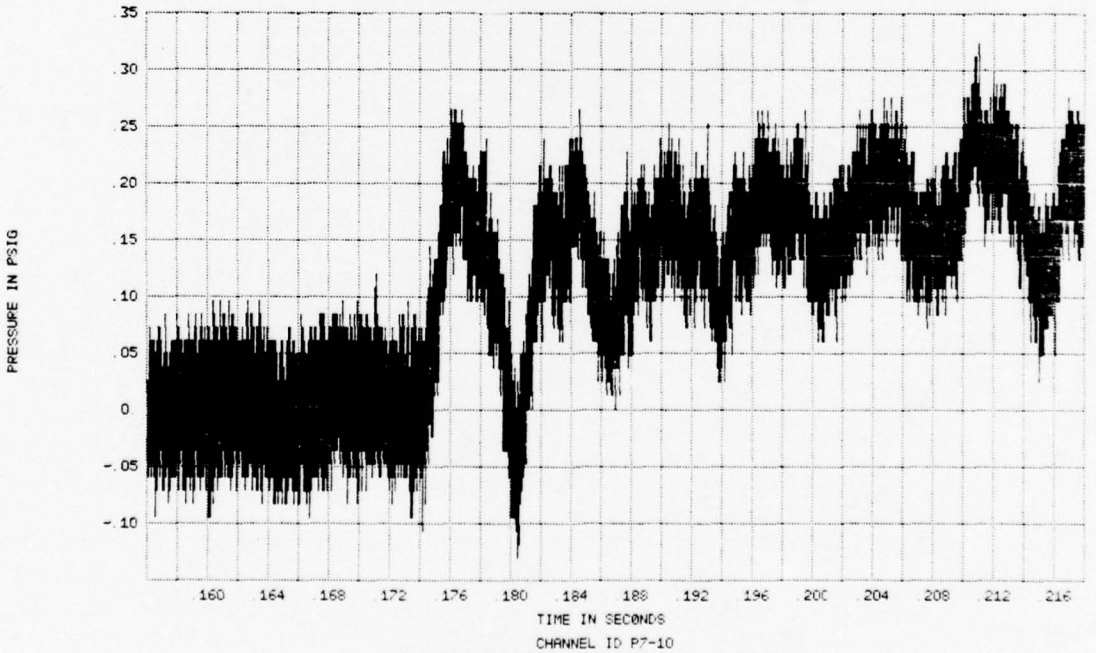


FIGURE 7-43 , SPECIMEN NO. 7 , SHOT NO. 4 ,
INTERNAL PRESSURE TIME HISTORY

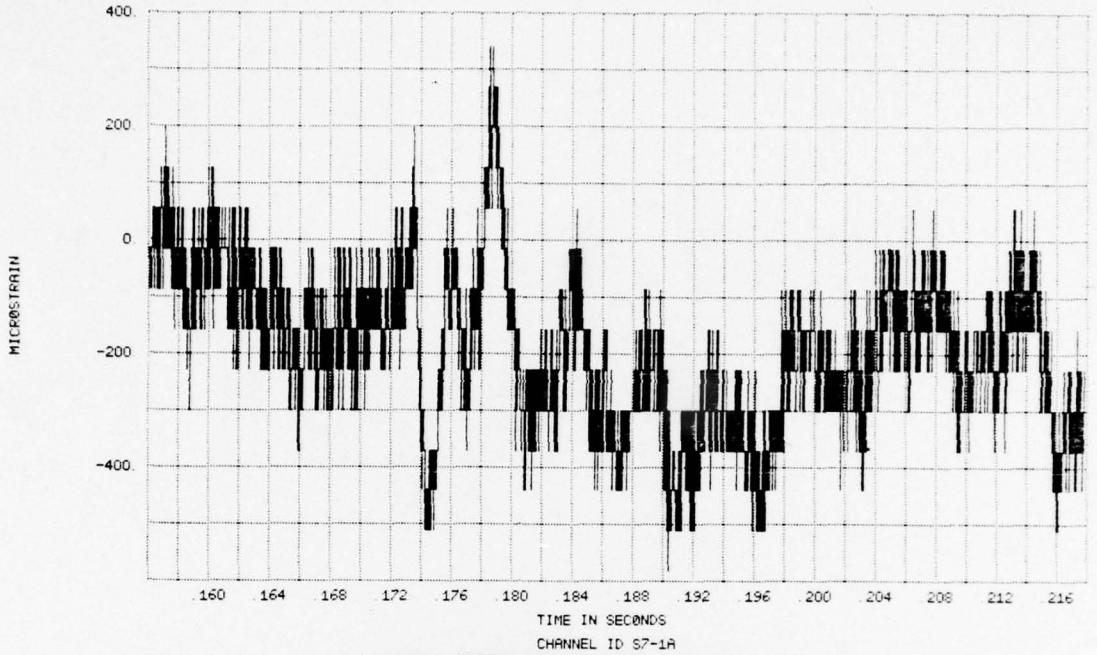


FIGURE 7-44 , SPECIMEN NO. 7 , SHOT NO. 4 , STRAIN TIME HISTORY

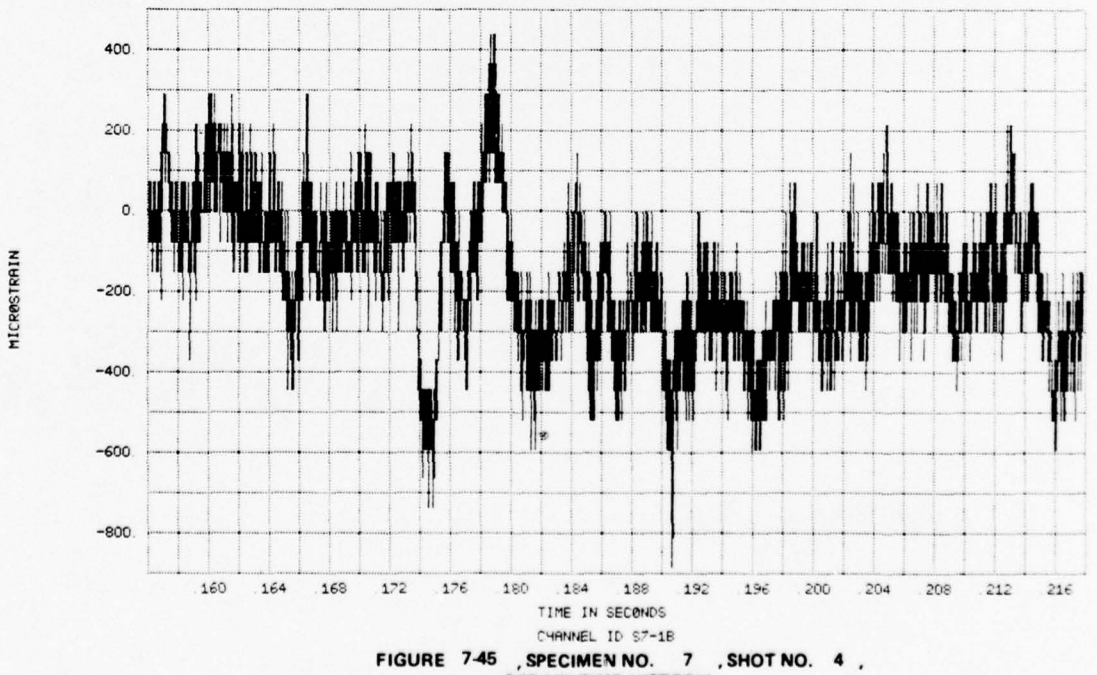


FIGURE 7-45 , SPECIMEN NO. 7 , SHOT NO. 4 , STRAIN TIME HISTORY

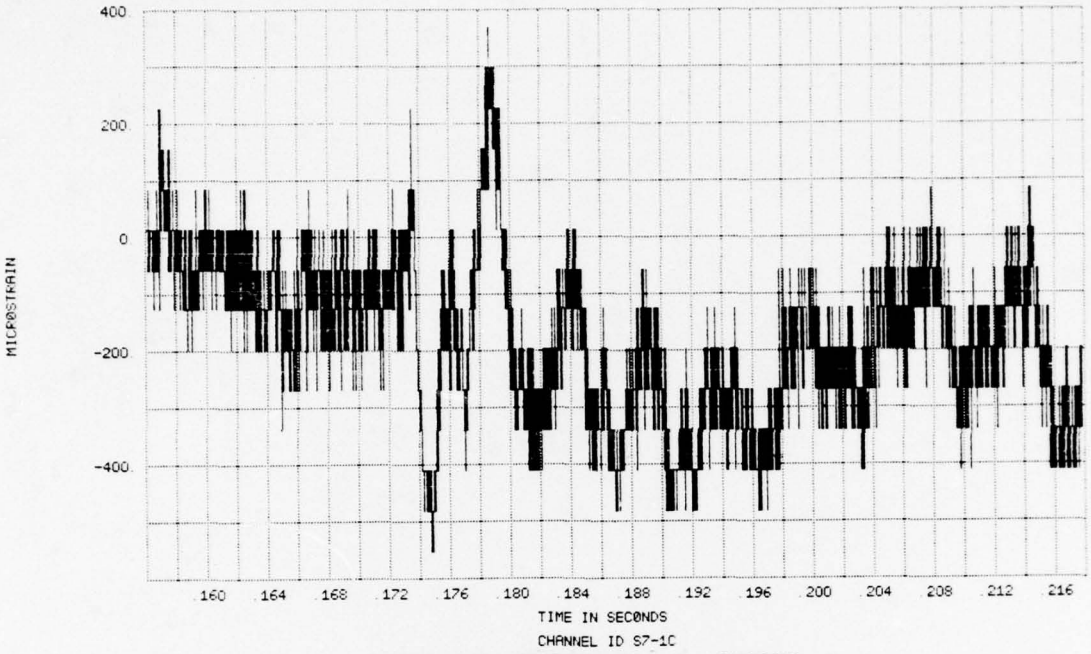


FIGURE 7-46 , SPECIMEN NO. 7 , SHOT NO. 4 , STRAIN TIME HISTORY

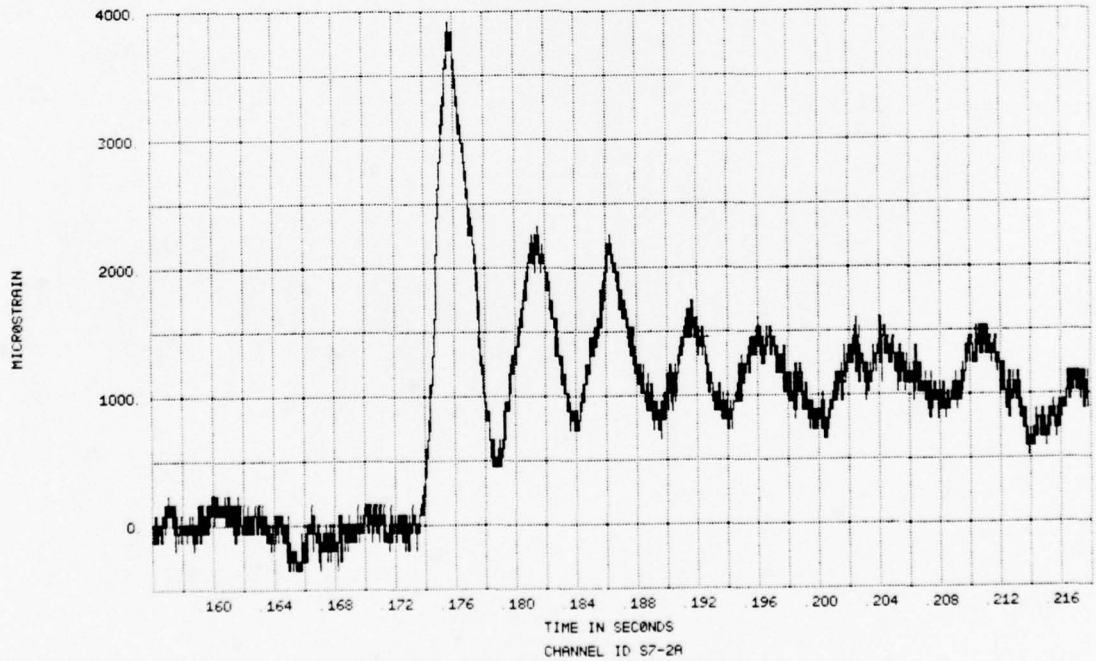


FIGURE 7-47 , SPECIMEN NO. 7 , SHOT NO. 4 , STRAIN TIME HISTORY

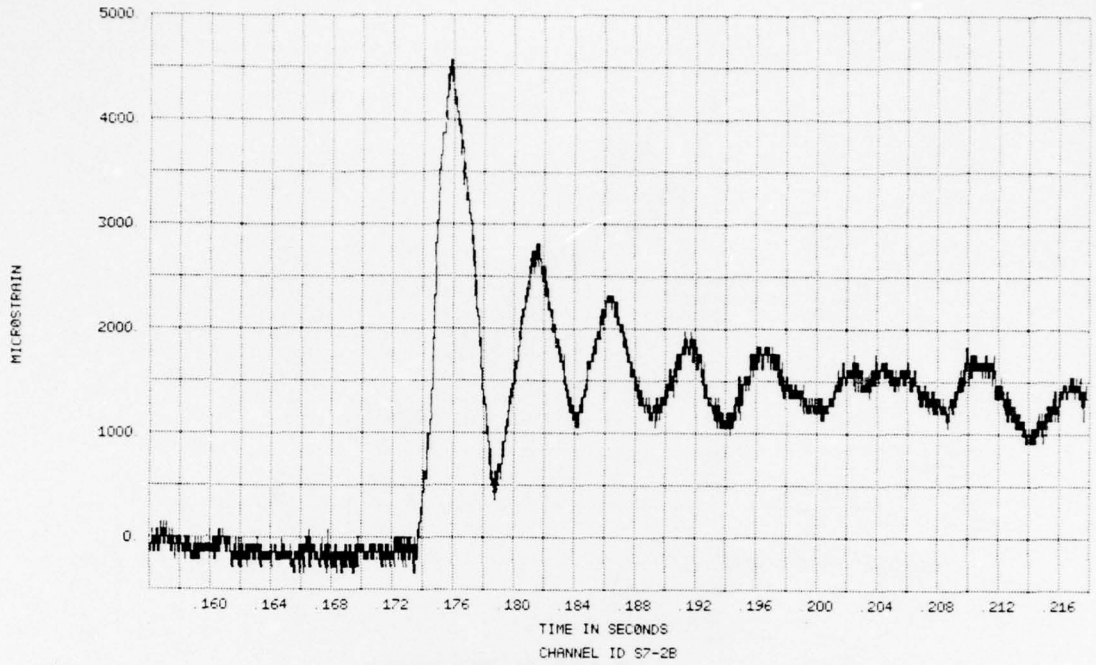


FIGURE 7-48 , SPECIMEN NO. 7 , SHOT NO. 4 , STRAIN TIME HISTORY

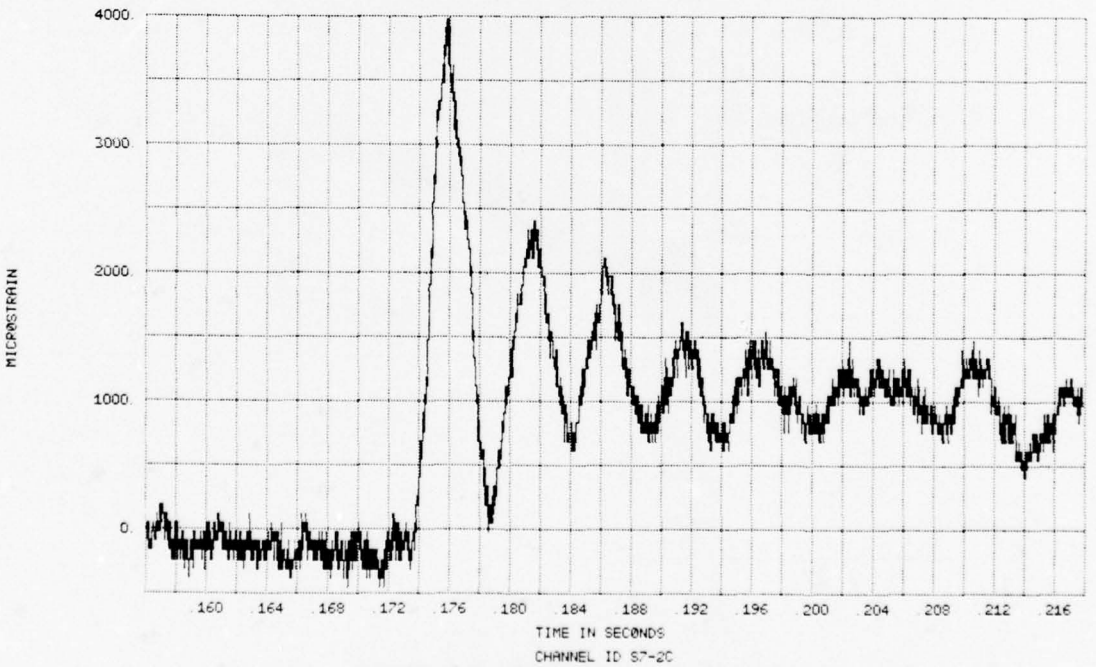


FIGURE 7-49 , SPECIMEN NO. 7 , SHOT NO. 4 , STRAIN TIME HISTORY

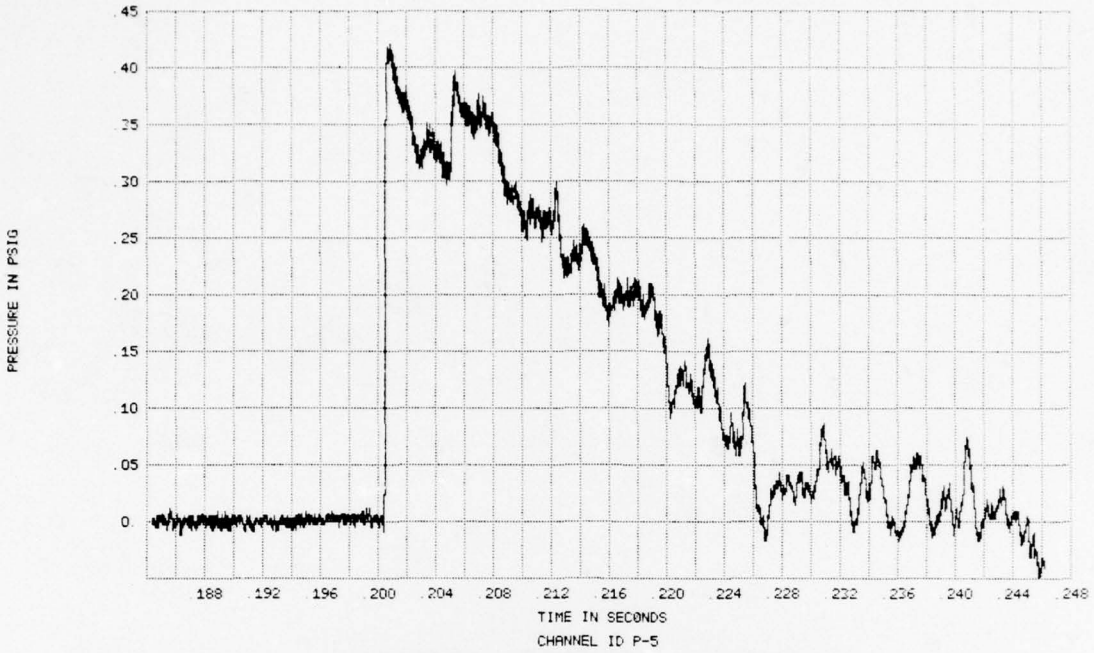


FIGURE 8-4 , SPECIMEN NO. 8 , SHOT NO. 2 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

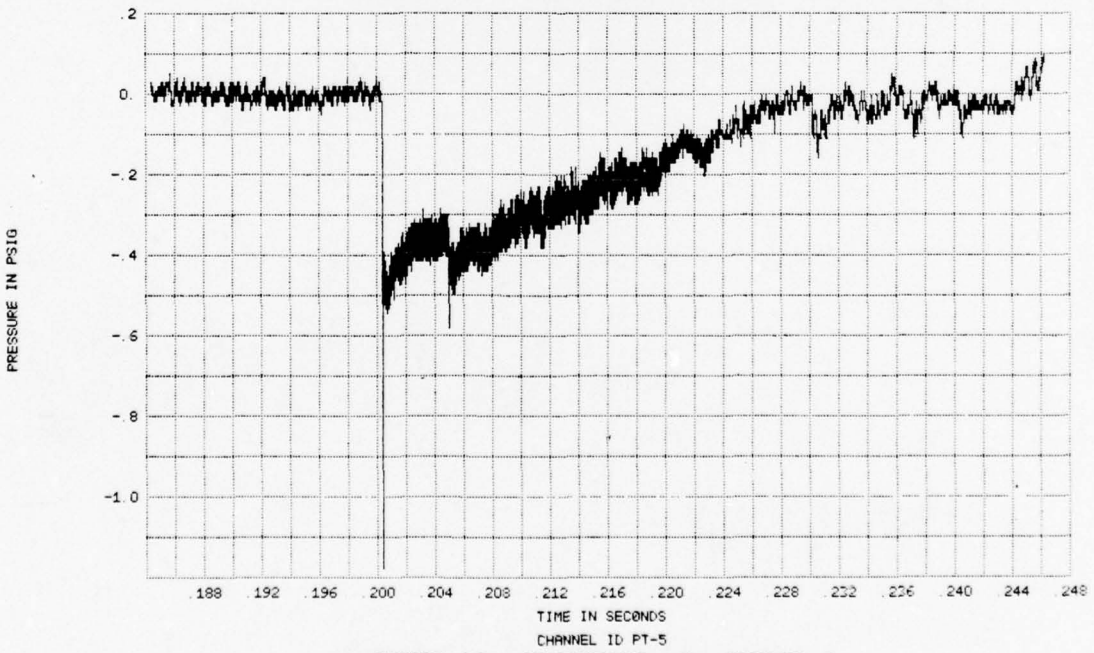


FIGURE 8-5 SPECIMEN NO. 8 , SHOT NO. 2 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

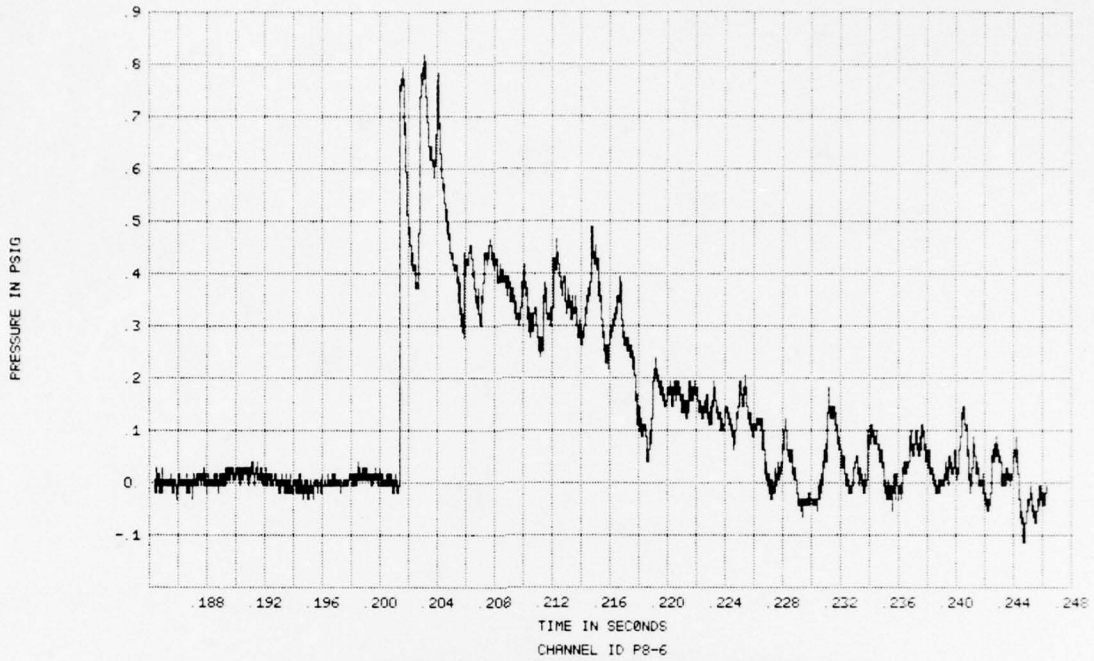


FIGURE 8-6 , SPECIMEN NO. 8 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

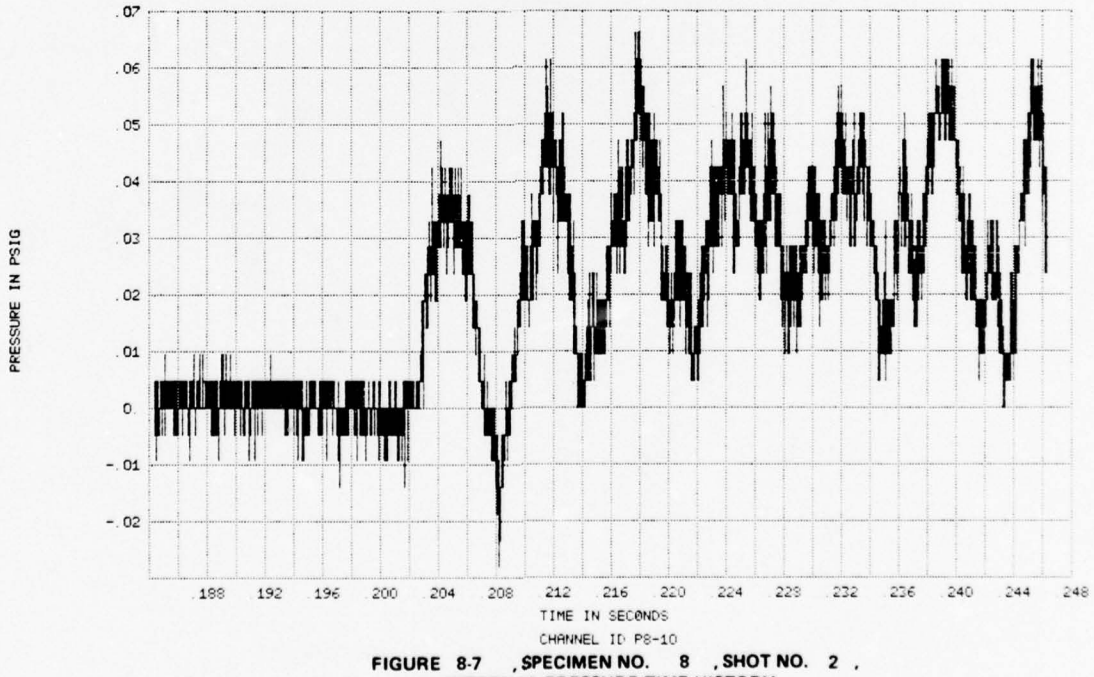


FIGURE 8-7 , SPECIMEN NO. 8 , SHOT NO. 2 ,
INTERNAL PRESSURE TIME HISTORY

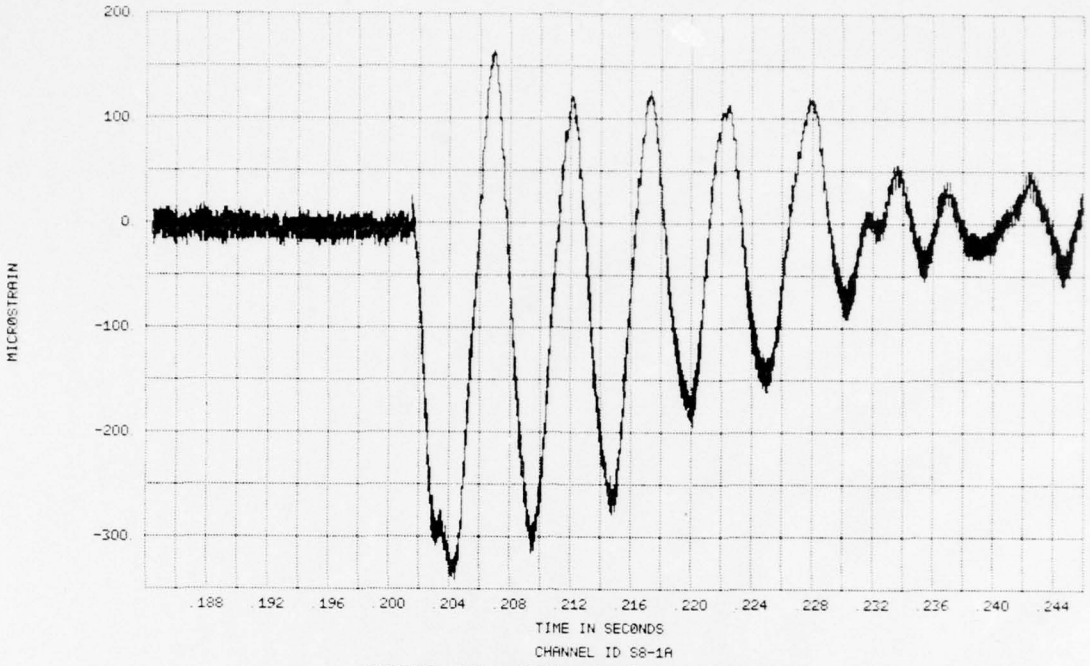


FIGURE 8-8 , SPECIMEN NO. 8 , SHOT NO. 2 , STRAIN TIME HISTORY

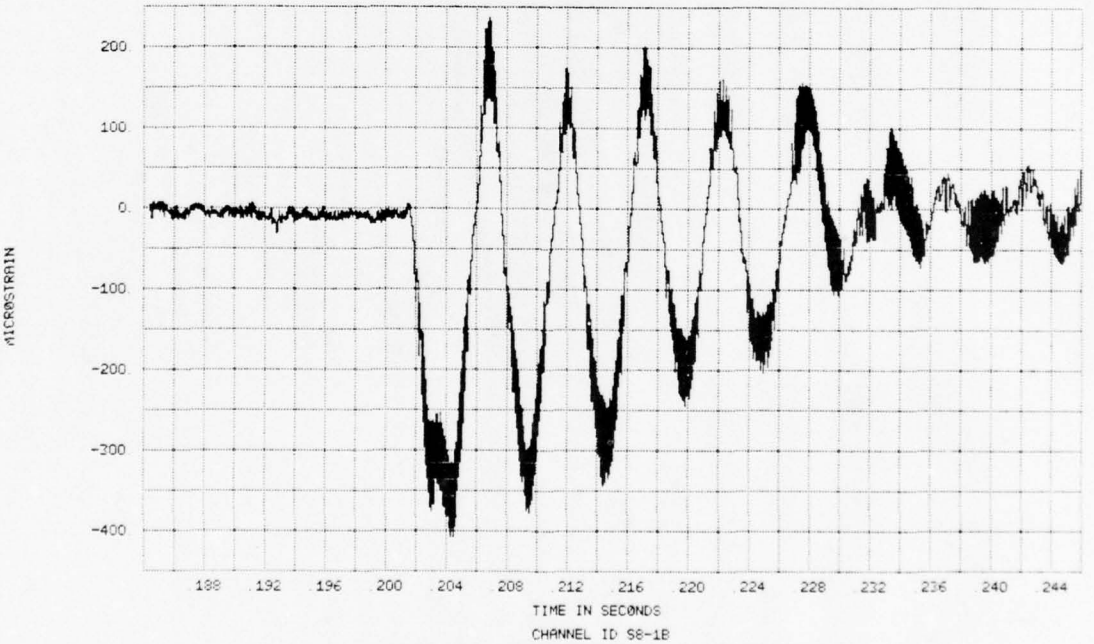


FIGURE 8-9 , SPECIMEN NO. 8 , SHOT NO. 2 , STRAIN TIME HISTORY

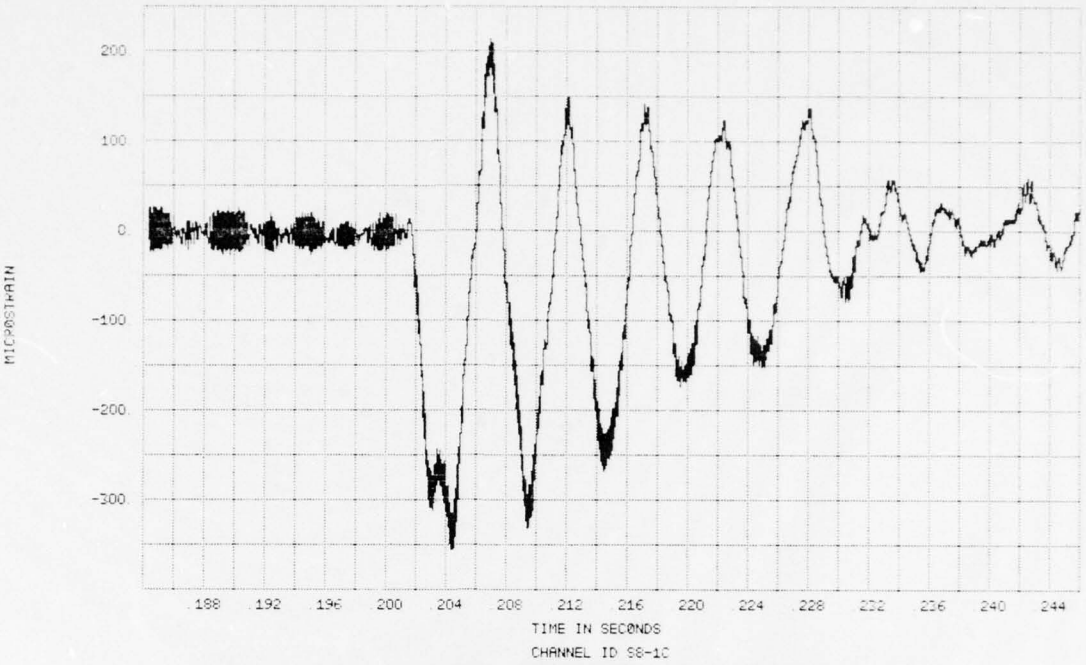


FIGURE 8-10 , SPECIMEN NO. 8 , SHOT NO. 2 ,
STRAIN TIME HISTORY

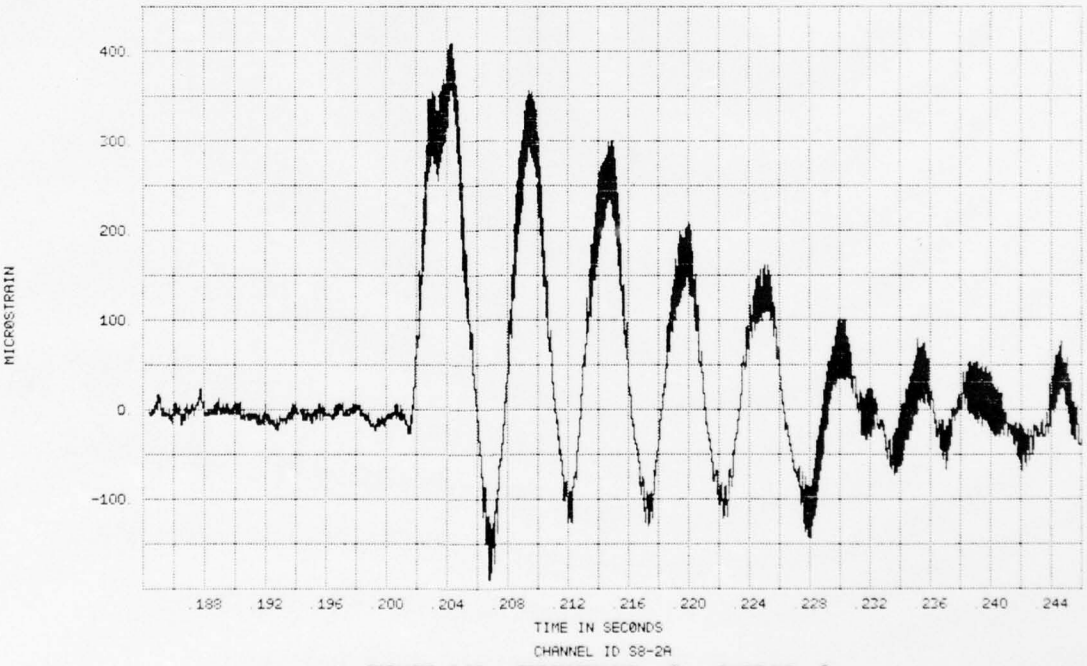


FIGURE 8-11 , SPECIMEN NO. 8 , SHOT NO. 2 ,
STRAIN TIME HISTORY

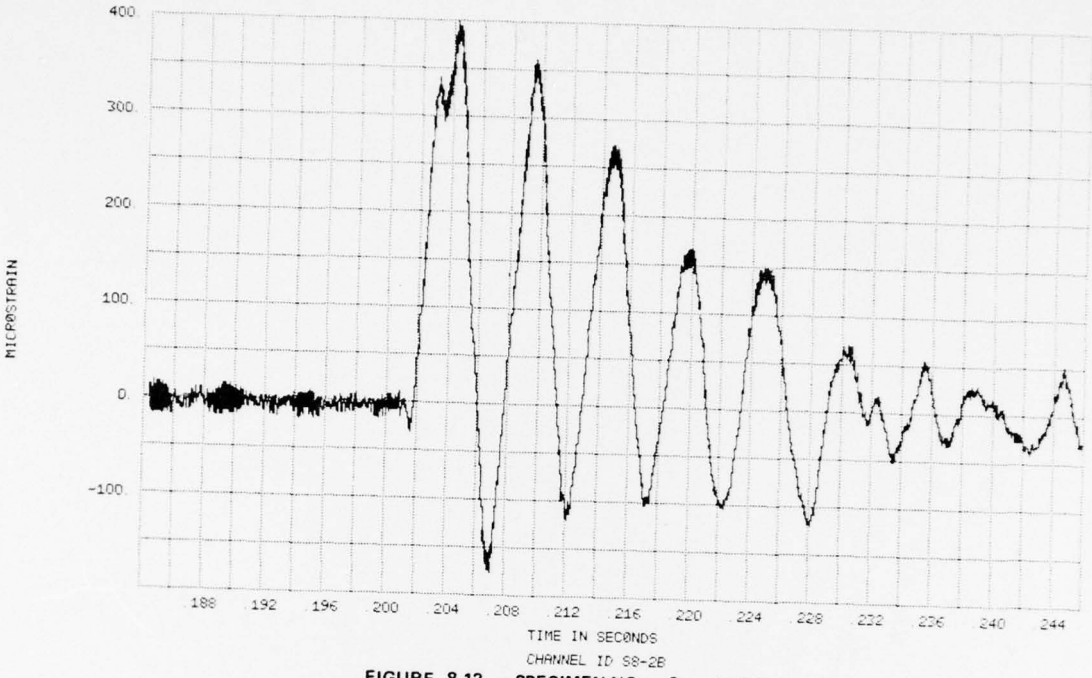


FIGURE 8-12 , SPECIMEN NO. 8 , SHOT NO. 2 ,
STRAIN TIME HISTORY

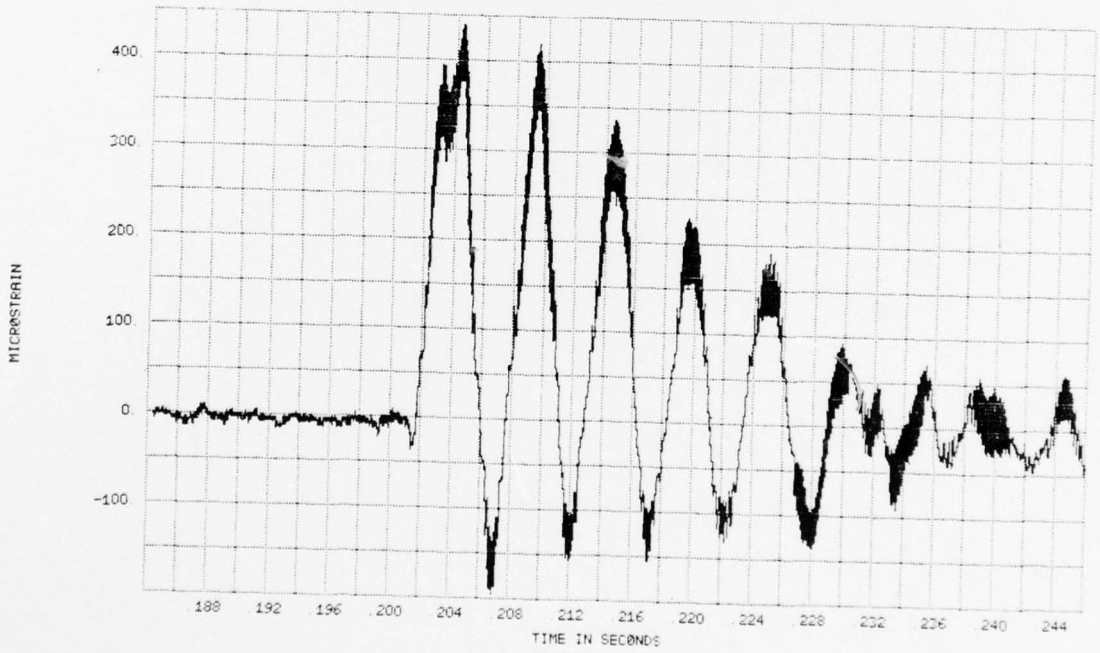


FIGURE 8-13 , SPECIMEN NO. 8 , SHOT NO. 2 ,
STRAIN TIME HISTORY

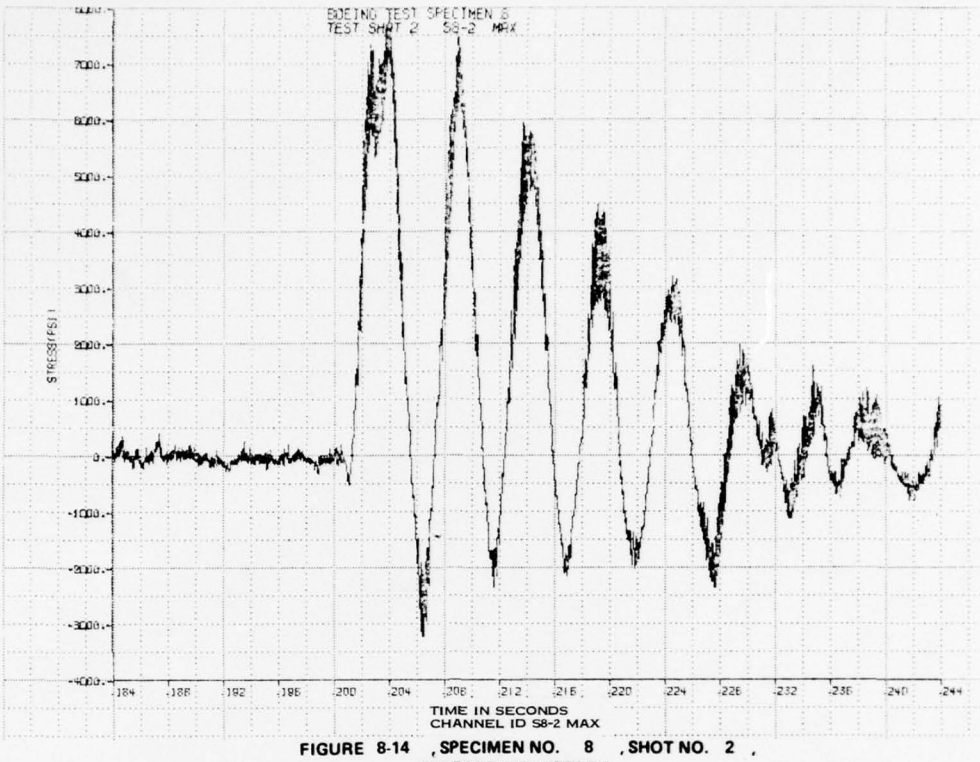


FIGURE 8-14 , SPECIMEN NO. 8 , SHOT NO. 2 , STRESS TIME HISTORY

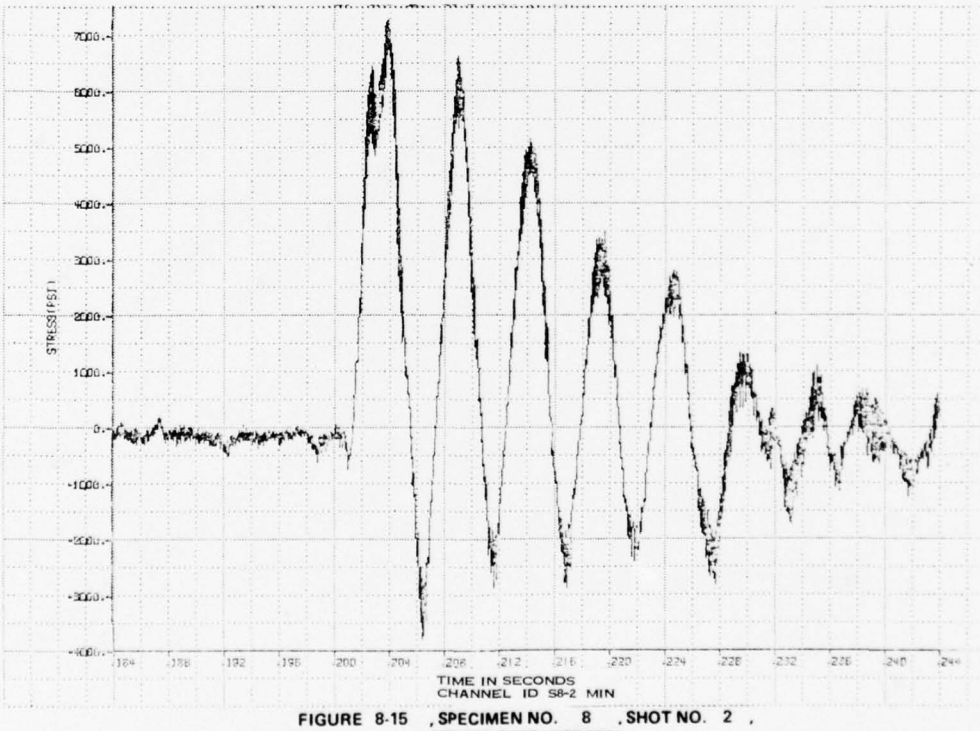


FIGURE 8-15 , SPECIMEN NO. 8 , SHOT NO. 2 , STRESS TIME HISTORY

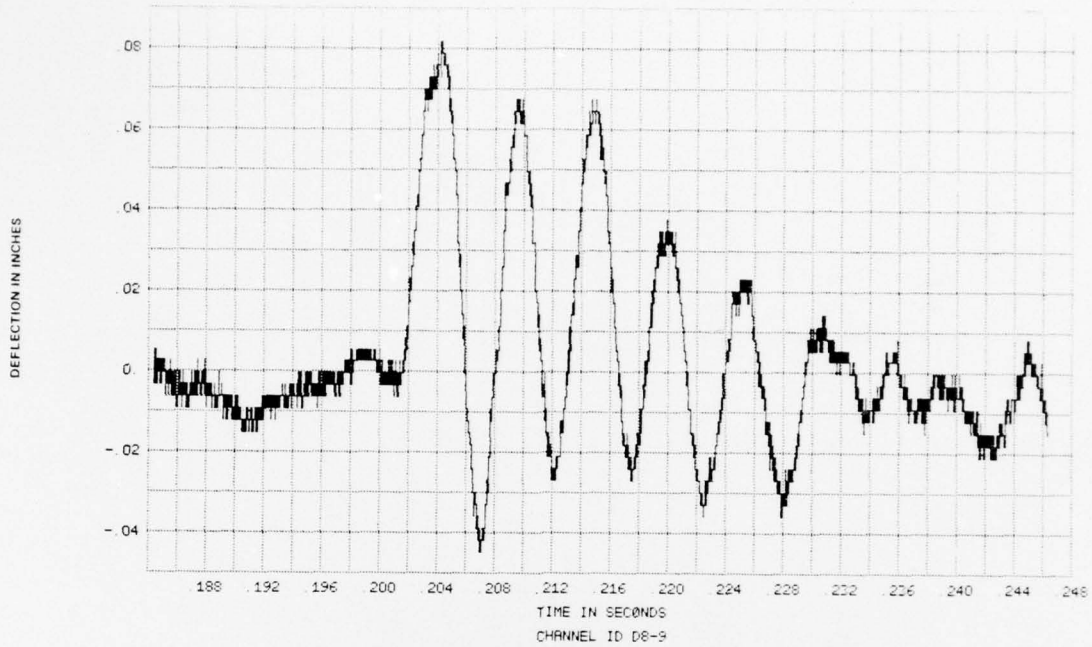


FIGURE 8-16 , SPECIMEN NO. 8 , SHOT NO. 2 ,
DEFLECTION TIME HISTORY

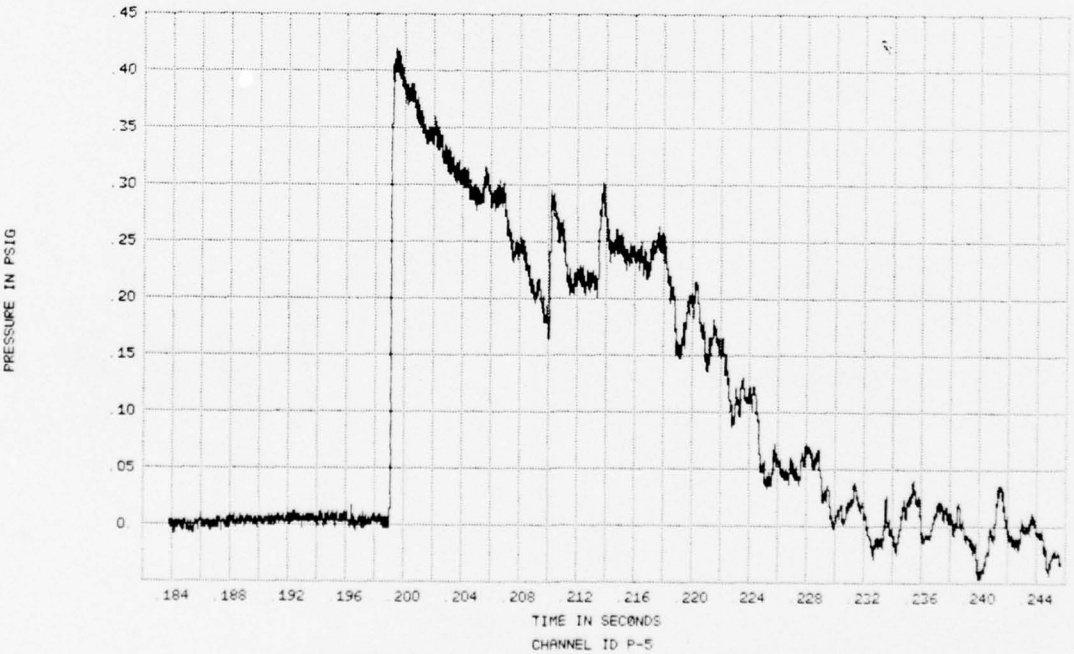


FIGURE 8-17 , SPECIMEN NO. 8 , SHOT NO. 3 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

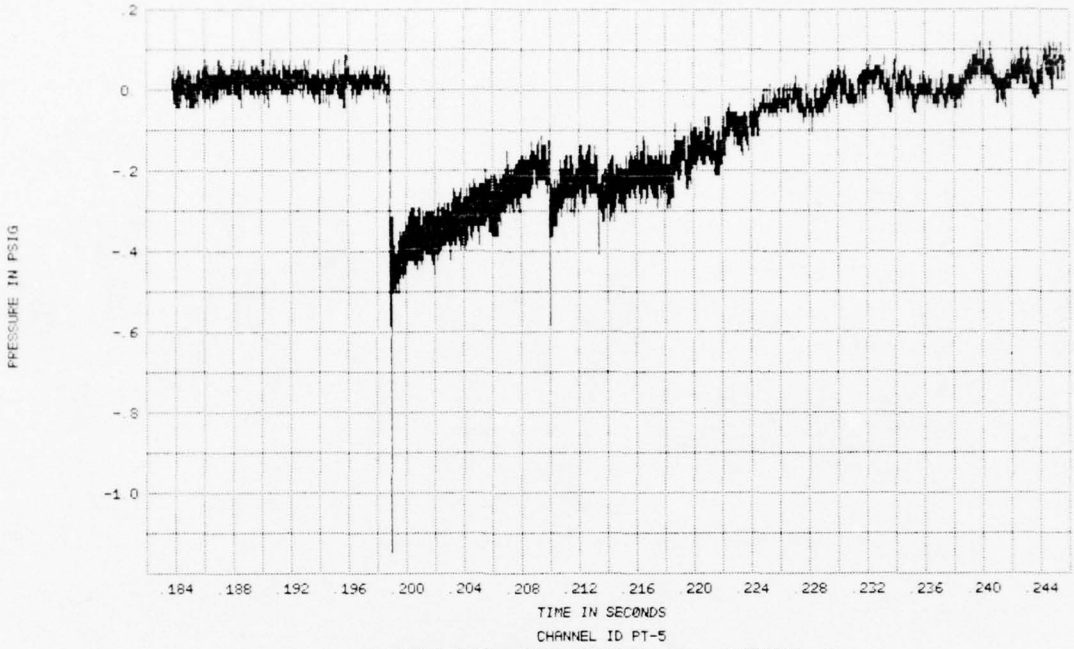


FIGURE 8-18 , SPECIMEN NO. 8 , SHOT NO. 3 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

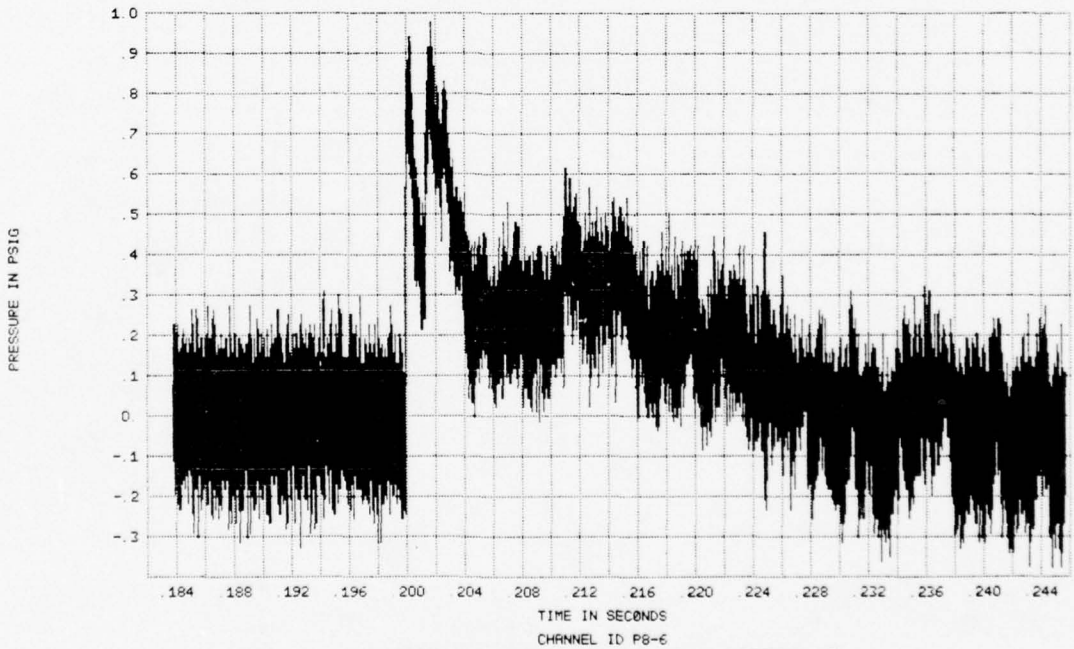


FIGURE 8-19 , SPECIMEN NO. 8 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

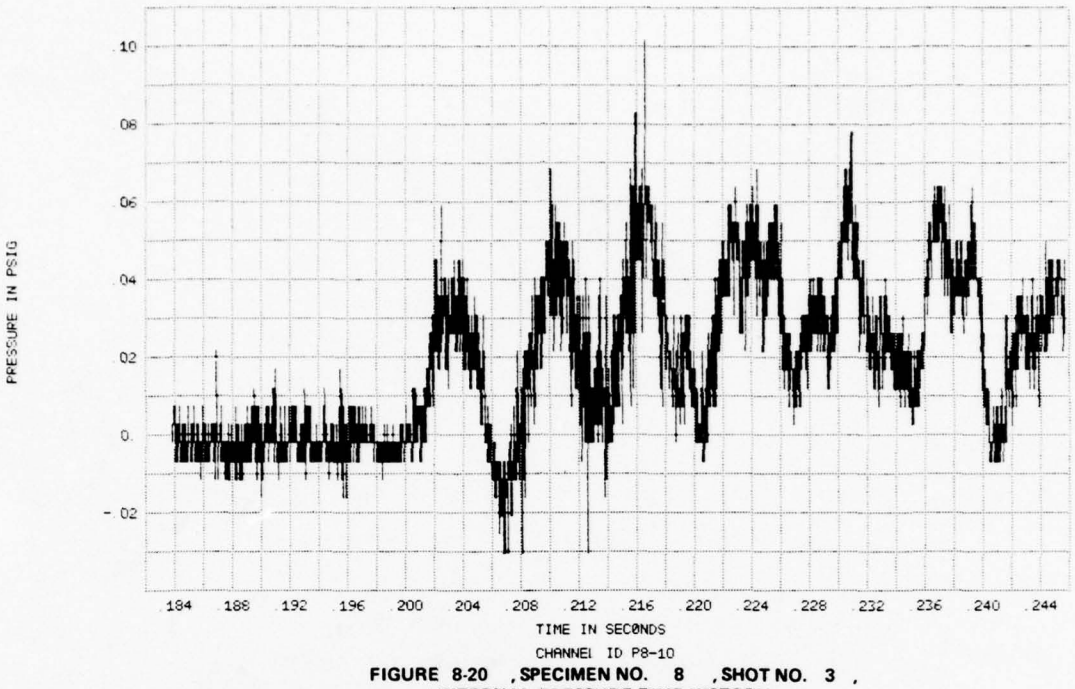


FIGURE 8-20 , SPECIMEN NO. 8 , SHOT NO. 3 ,
INTERNAL PRESSURE TIME HISTORY

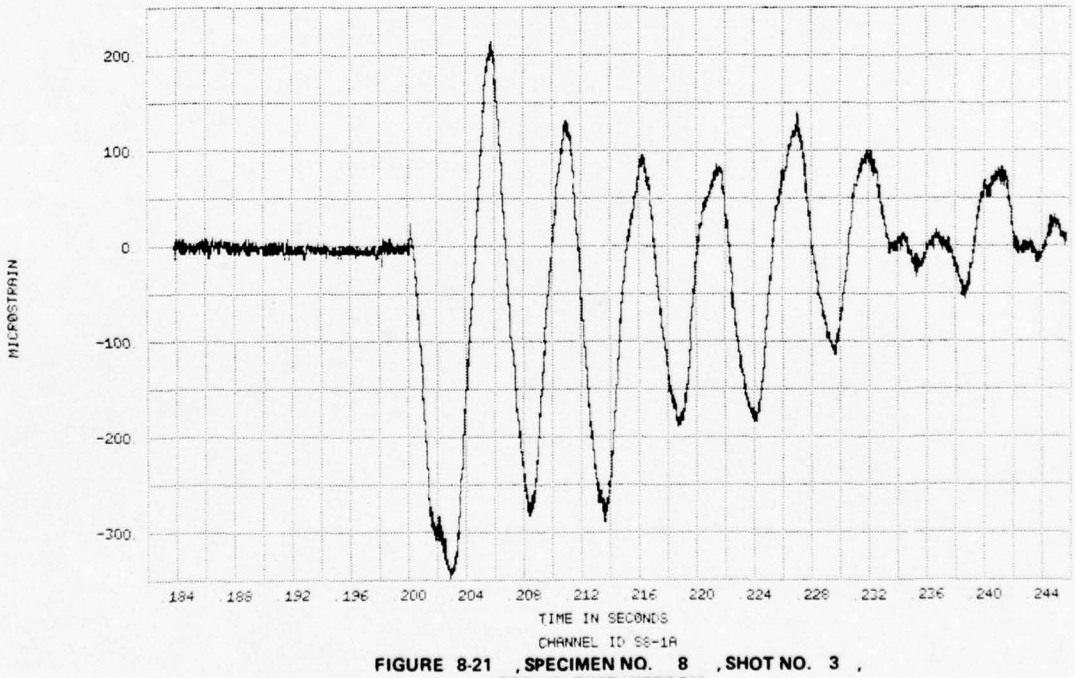


FIGURE 8-21 , SPECIMEN NO. 8 , SHOT NO. 3 ,
STRAIN TIME HISTORY

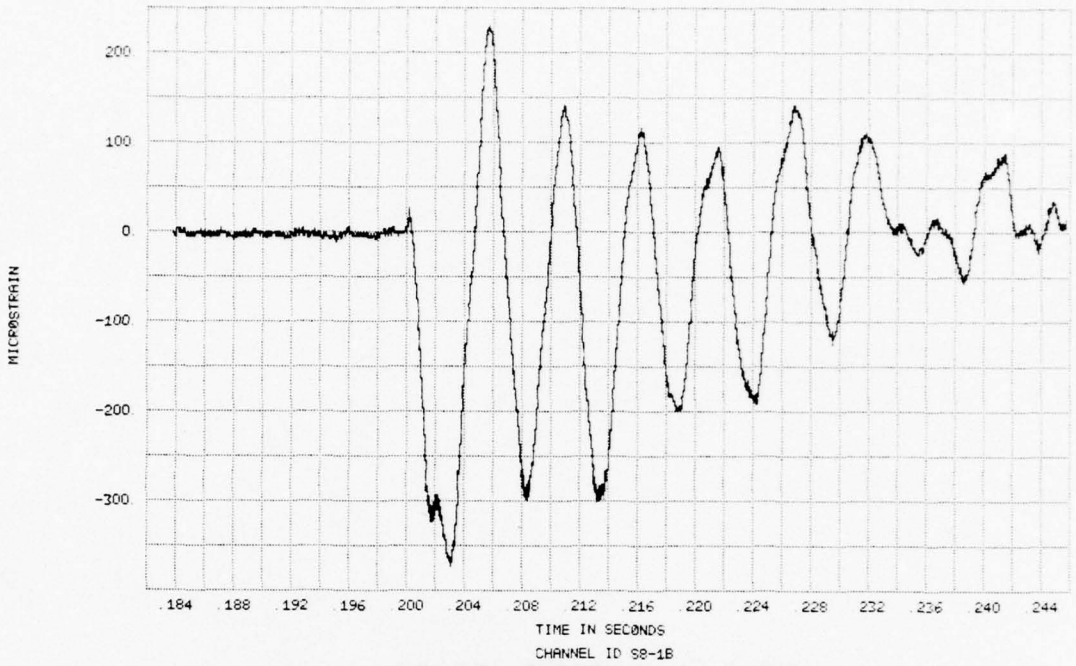


FIGURE 8-22 , SPECIMEN NO. 8 , SHOT NO. 3 , STRAIN TIME HISTORY

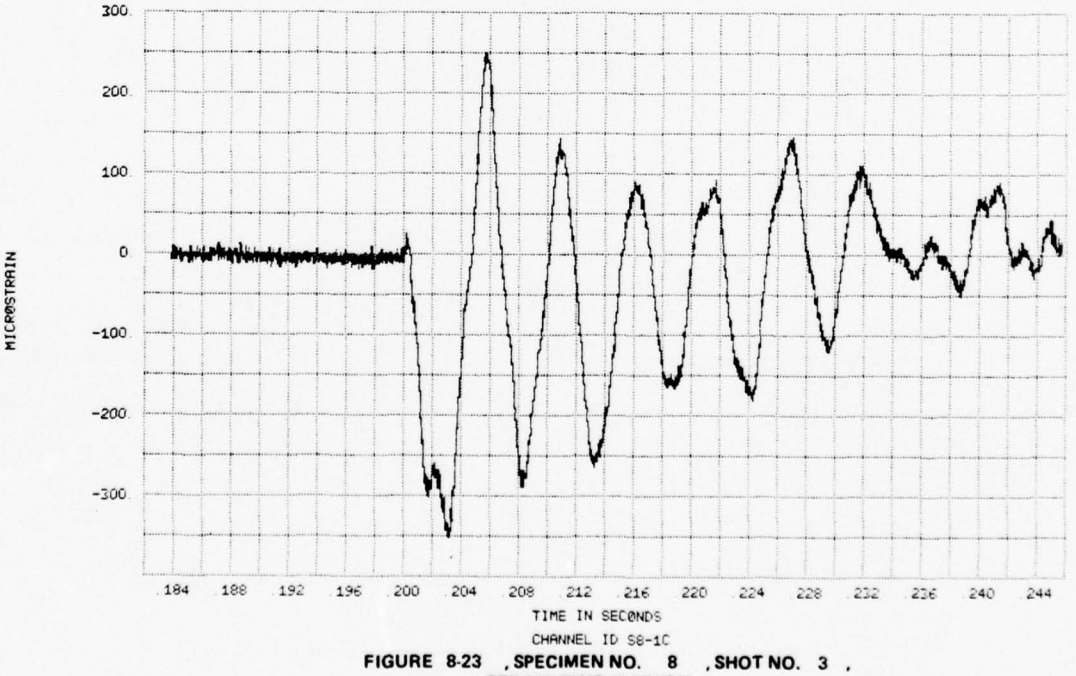


FIGURE 8-23 , SPECIMEN NO. 8 , SHOT NO. 3 , STRAIN TIME HISTORY

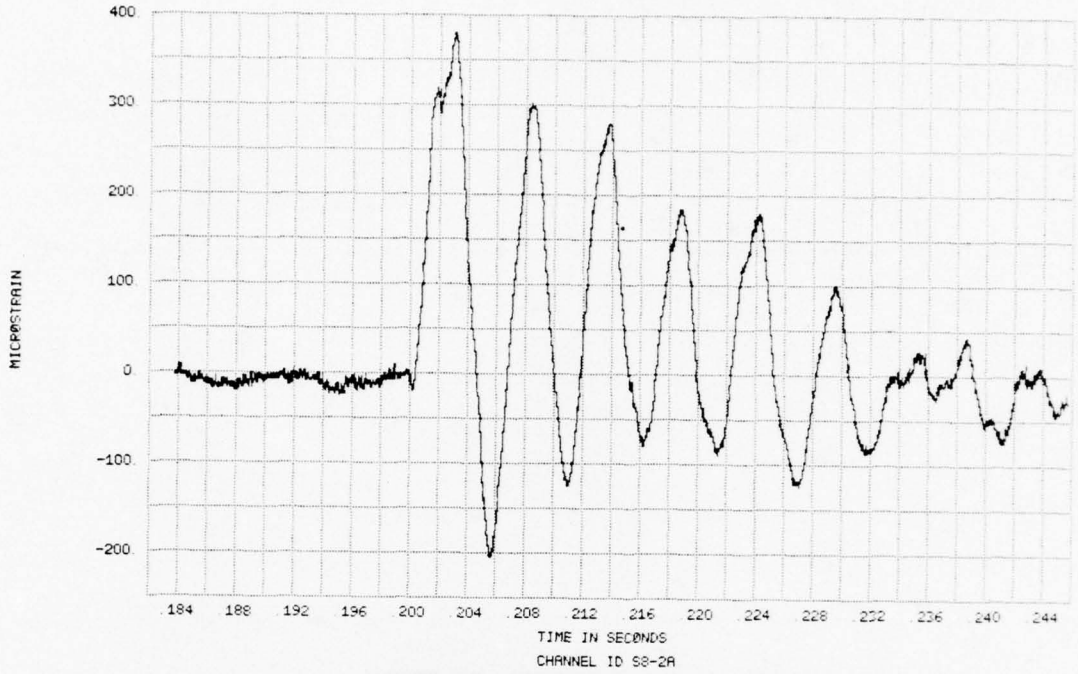


FIGURE 8-24 , SPECIMEN NO. 8 , SHOT NO. 3 , STRAIN TIME HISTORY

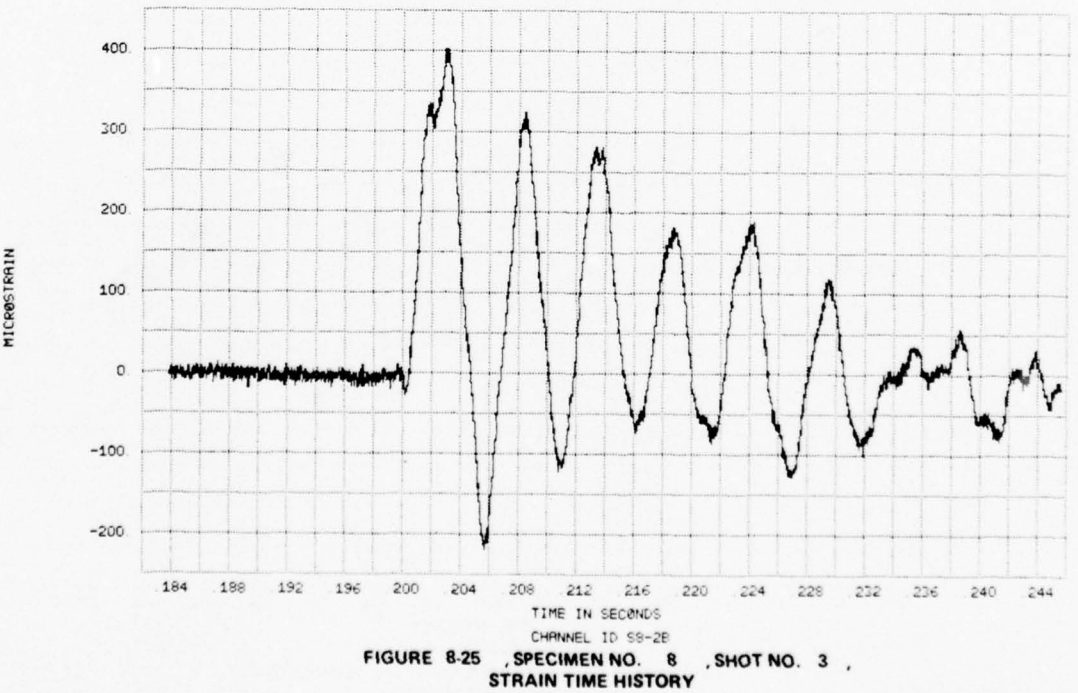


FIGURE 8-25 , SPECIMEN NO. 8 , SHOT NO. 3 , STRAIN TIME HISTORY

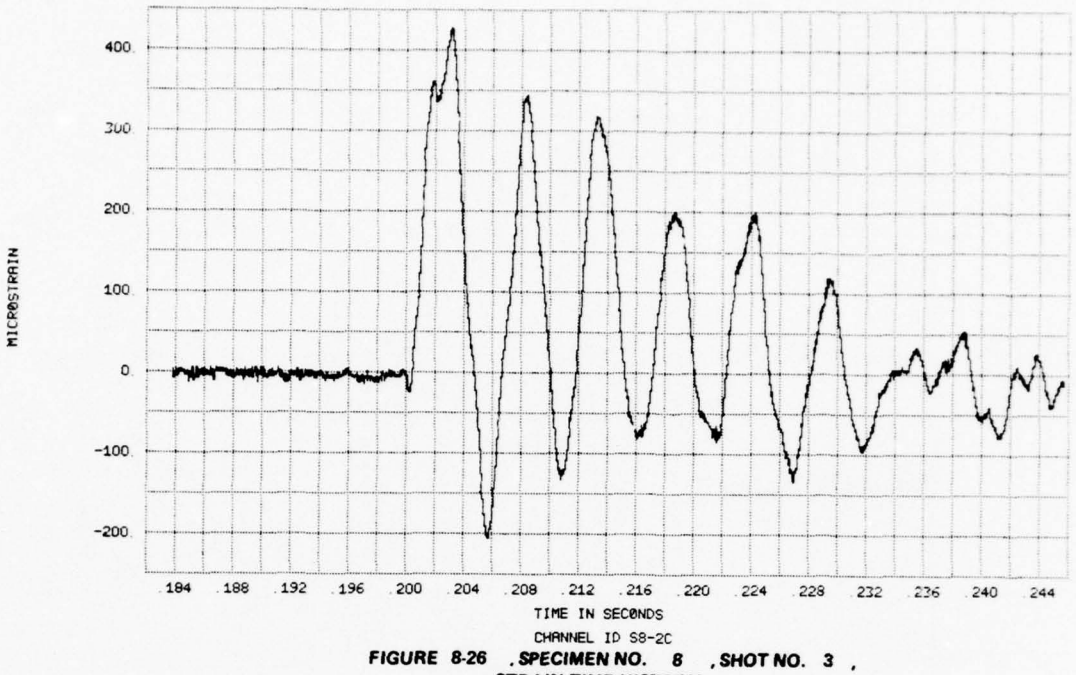


FIGURE 8-26 , SPECIMEN NO. 8 , SHOT NO. 3 ,
STRAIN TIME HISTORY

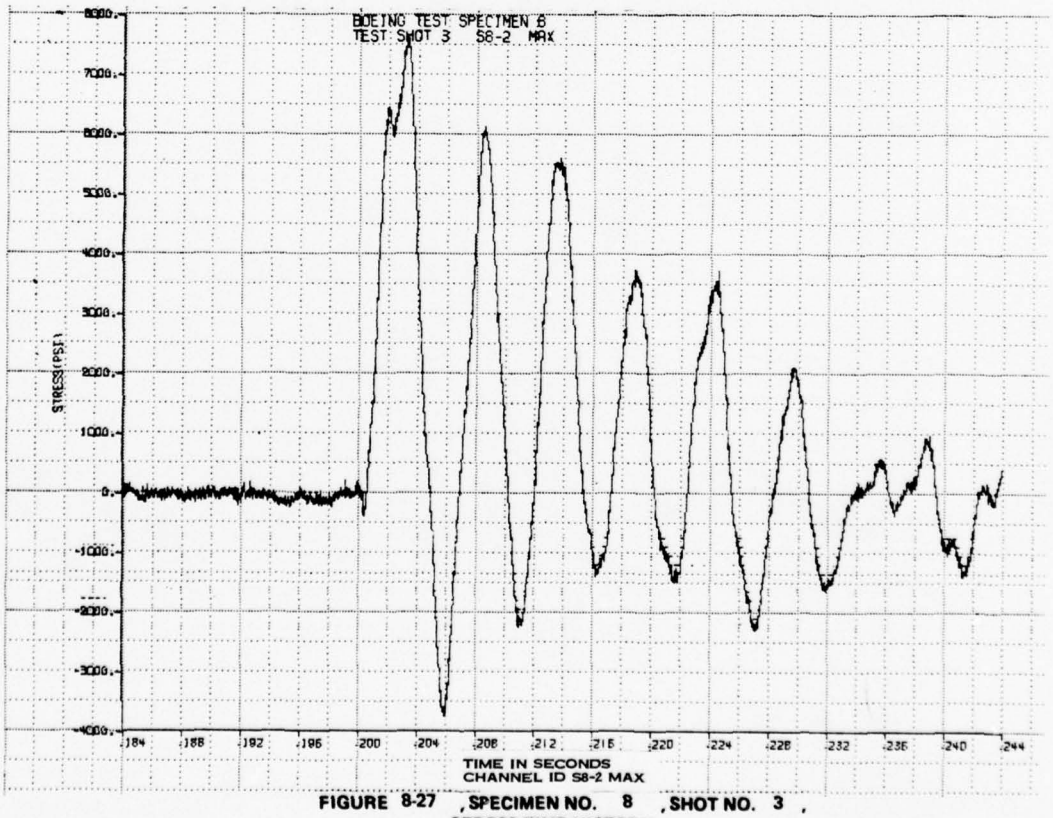


FIGURE 8-27 , SPECIMEN NO. 8 , SHOT NO. 3 ,
STRESS TIME HISTORY

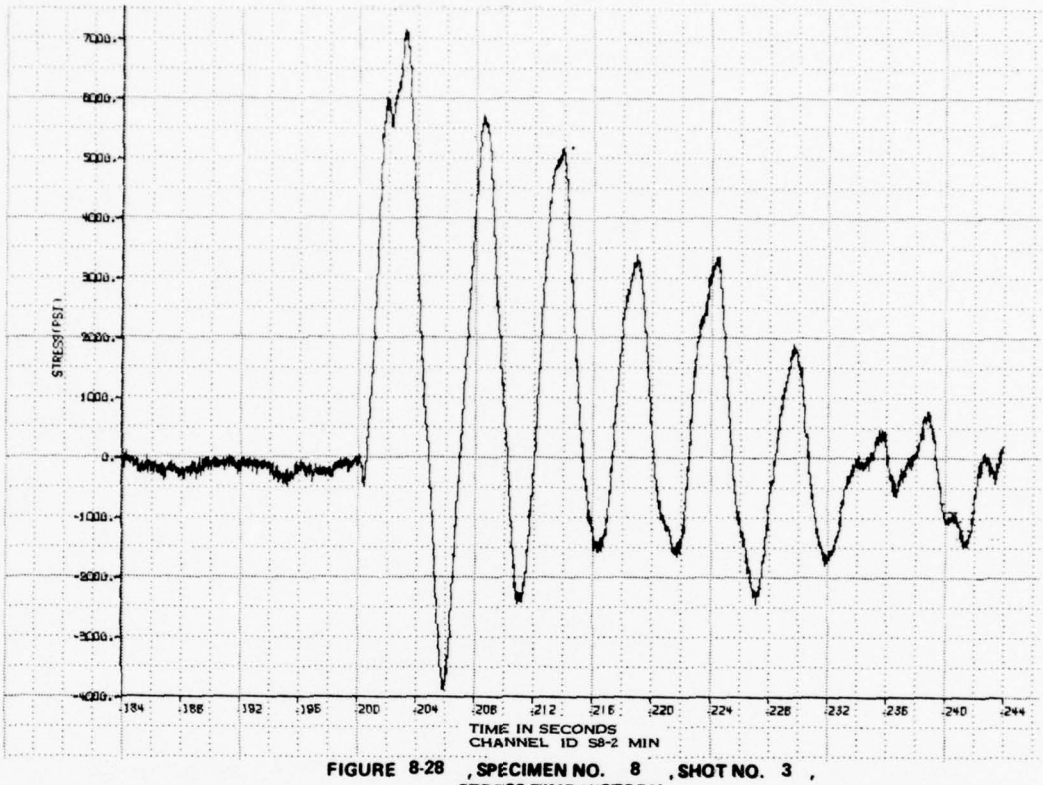


FIGURE 8-28 , SPECIMEN NO. 8 , SHOT NO. 3 ,
STRESS TIME HISTORY

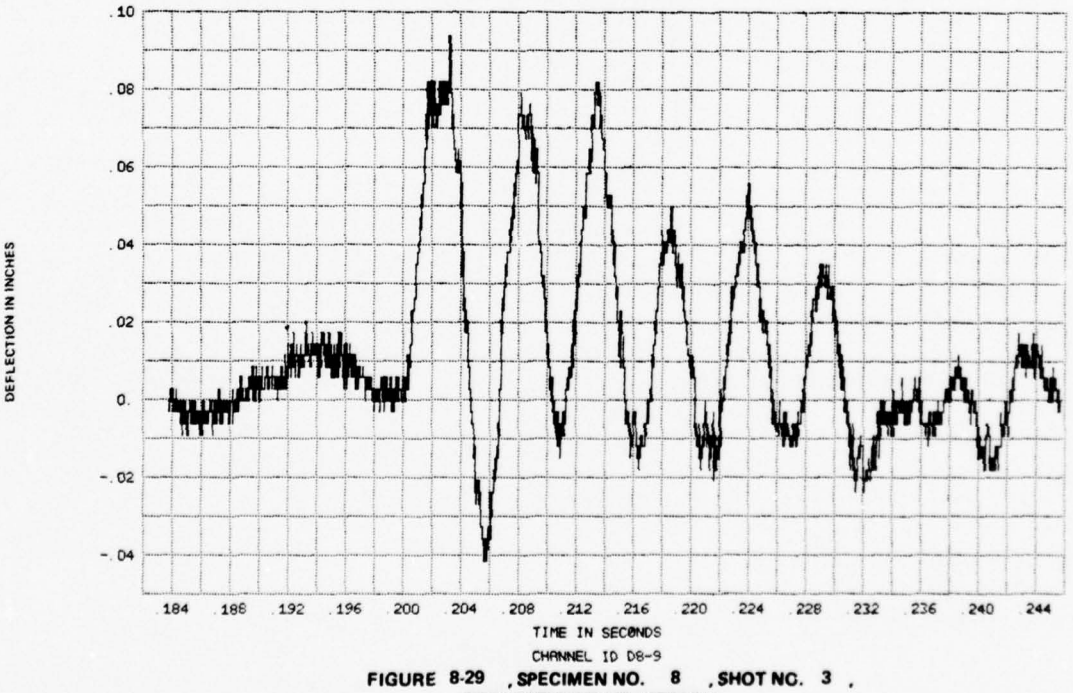


FIGURE 8-29 , SPECIMEN NO. 8 , SHOT NO. 3 ,
DEFLECTION TIME HISTORY

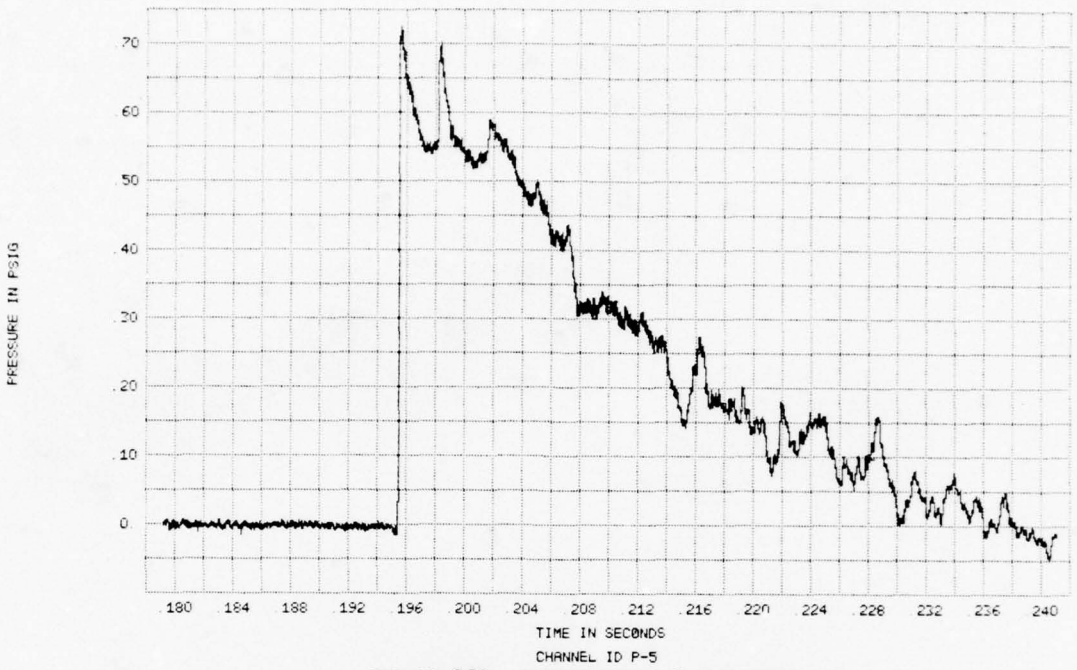


FIGURE 8-30 , SPECIMEN NO. 8 , SHOT NO. 4 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

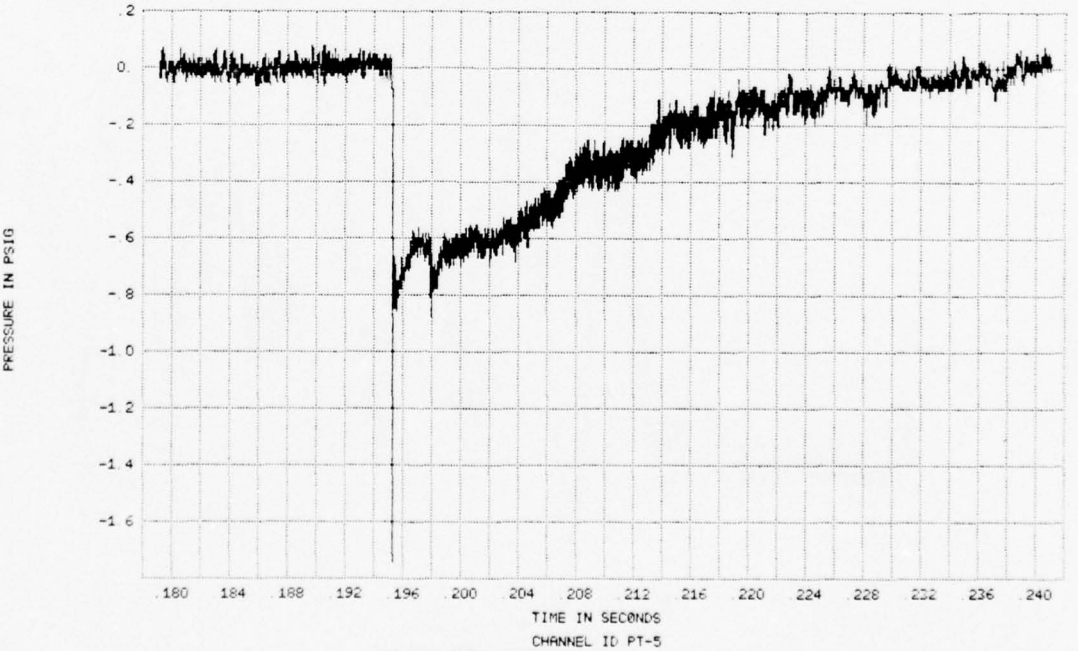


FIGURE 8-31 , SPECIMEN NO. 8 , SHOT NO. 4 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

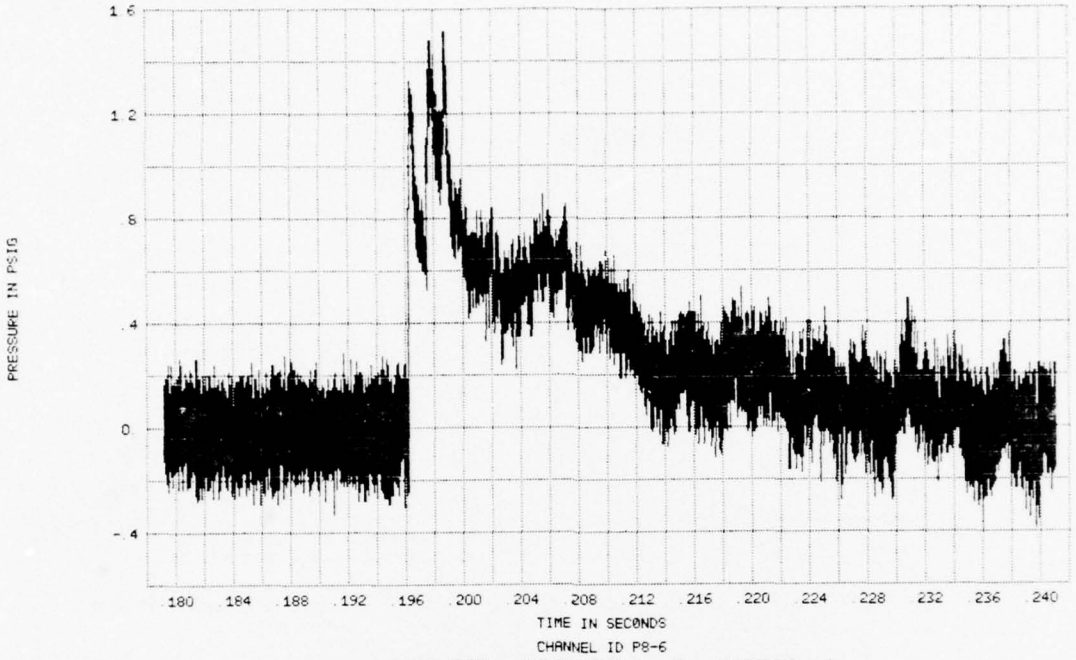


FIGURE 8-32 , SPECIMEN NO. 8 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

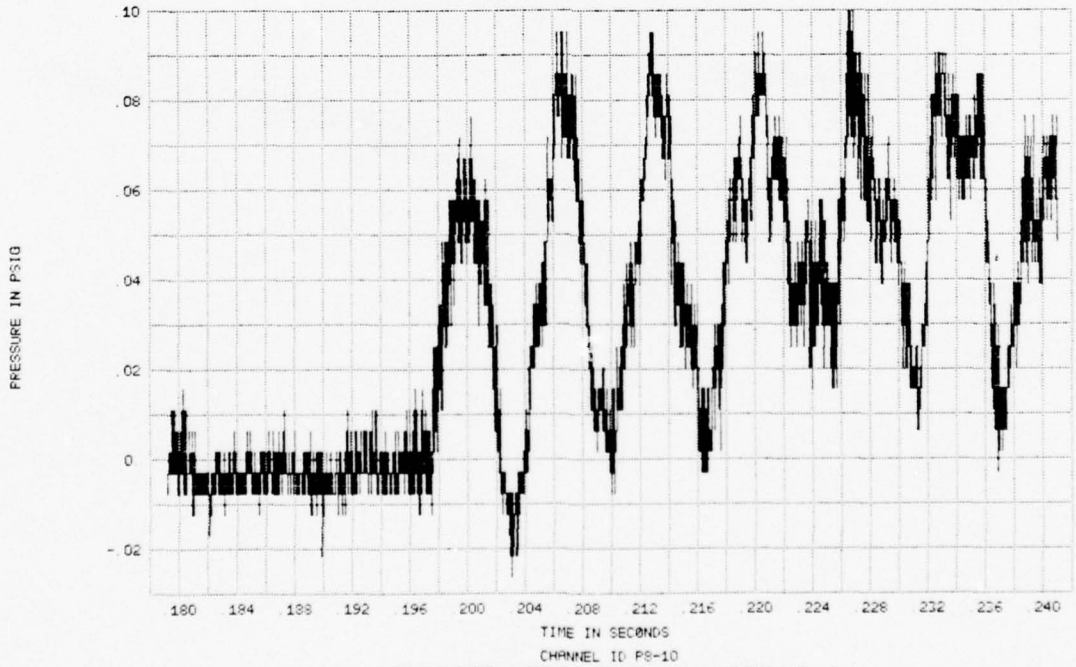


FIGURE 8-33 , SPECIMEN NO. 8 , SHOT NO. 4 ,
INTERNAL PRESSURE TIME HISTORY

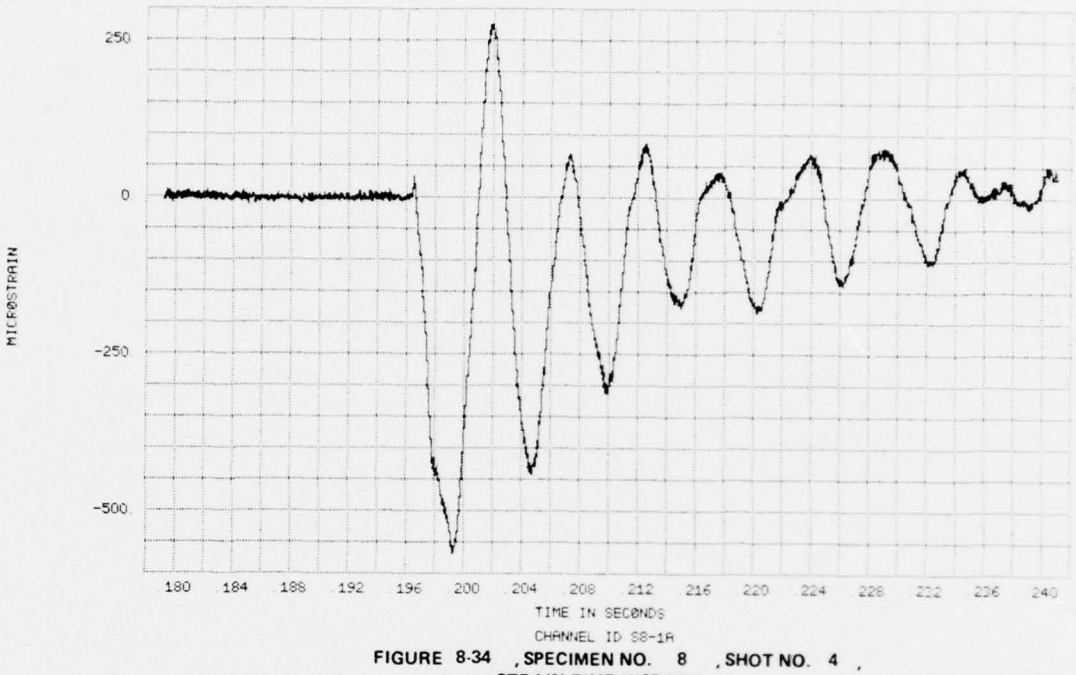


FIGURE 8-34 , SPECIMEN NO. 8 , SHOT NO. 4 , STRAIN TIME HISTORY

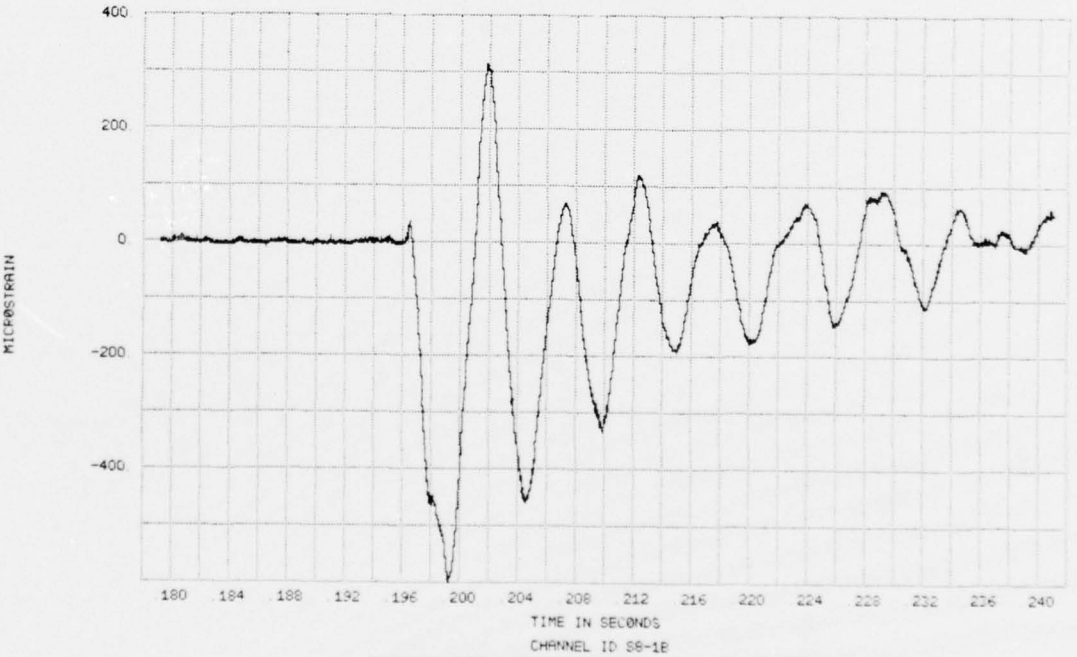


FIGURE 8-35 , SPECIMEN NO. 8 , SHOT NO. 4 , STRAIN TIME HISTORY

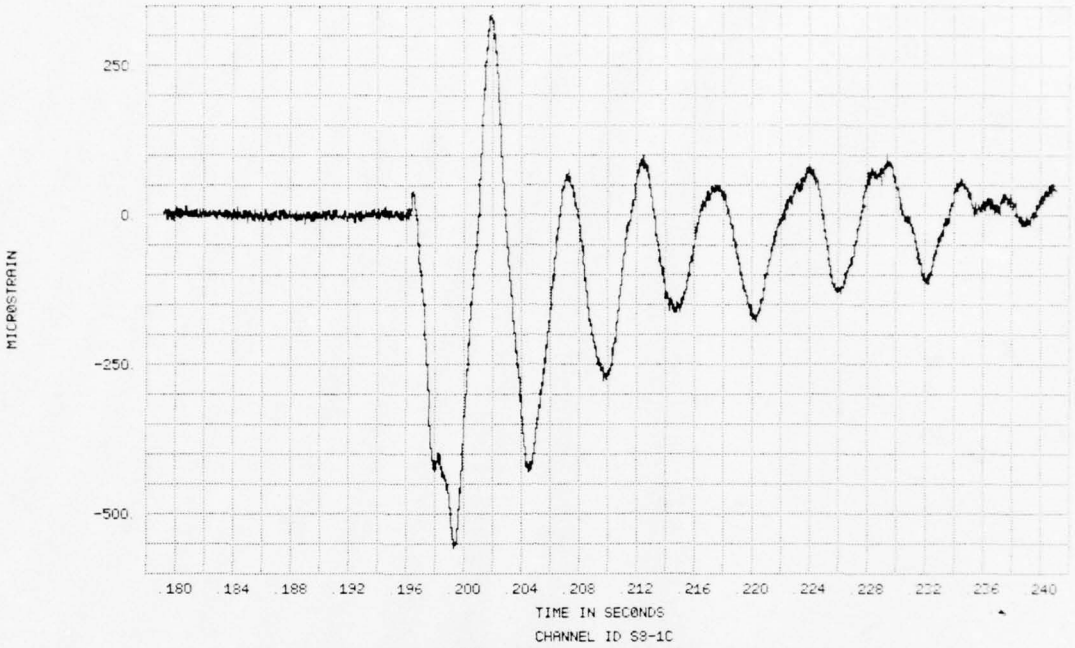


FIGURE 8-36 , SPECIMEN NO. 8 , SHOT NO. 4 , STRAIN TIME HISTORY

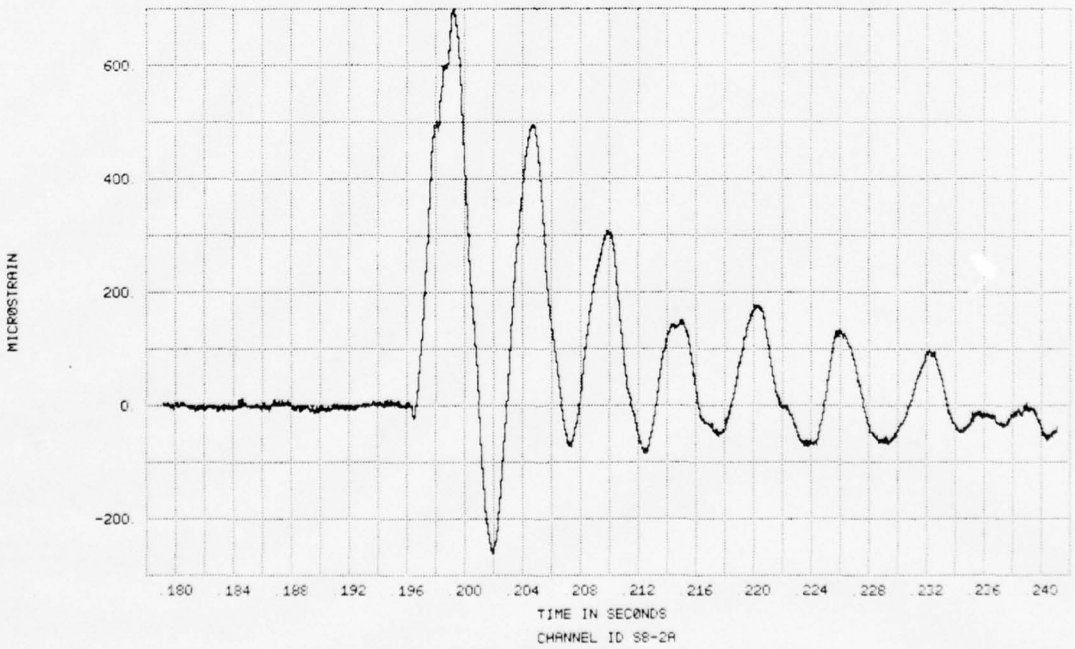


FIGURE 8-37 , SPECIMEN NO. 8 , SHOT NO. 4 , STRAIN TIME HISTORY

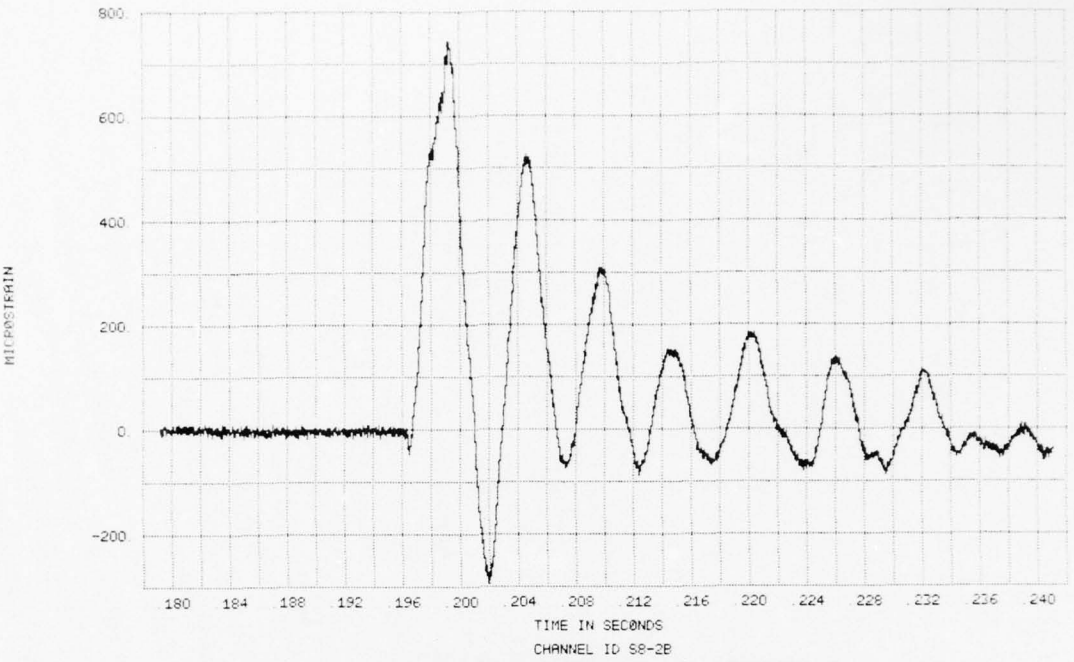


FIGURE 8-38 , SPECIMEN NO. 8 , SHOT NO. 4 , STRAIN TIME HISTORY

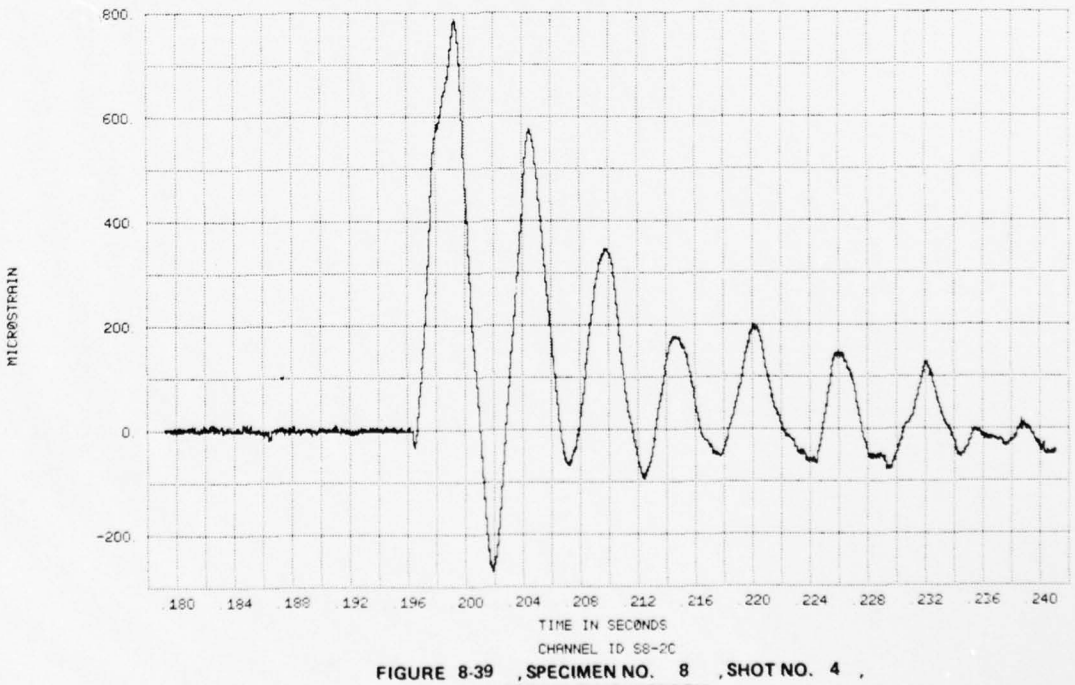


FIGURE 8-39 , SPECIMEN NO. 8 , SHOT NO. 4 , STRAIN TIME HISTORY

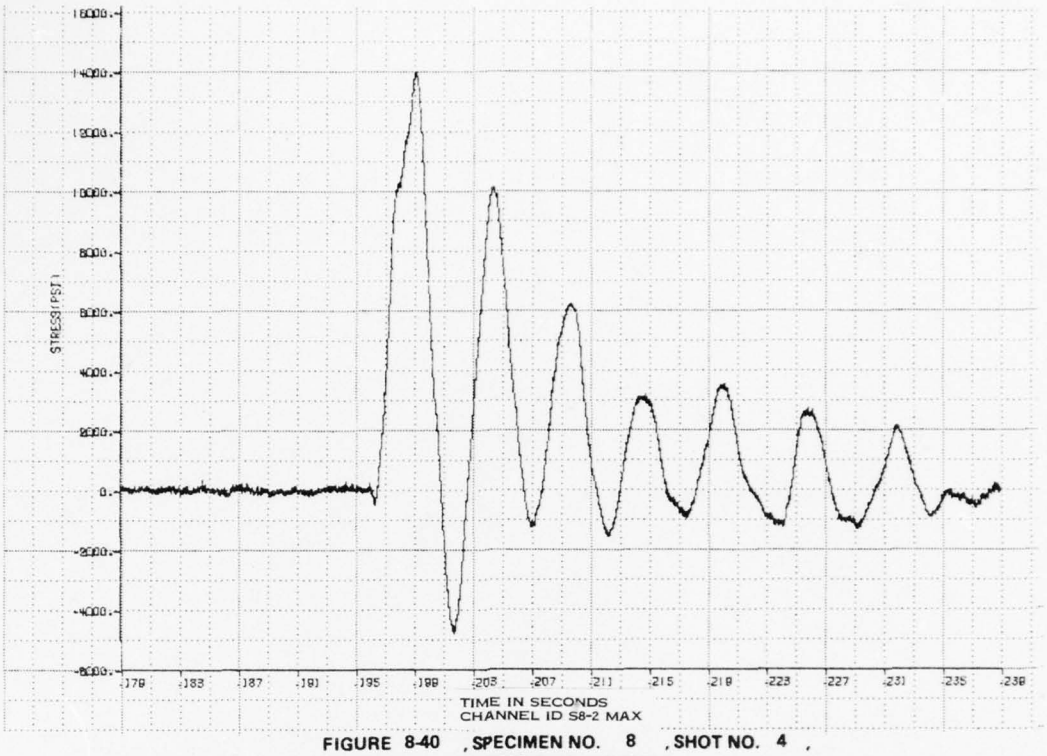


FIGURE 8-40 , SPECIMEN NO. 8 , SHOT NO. 4 ,
STRESS TIME HISTORY

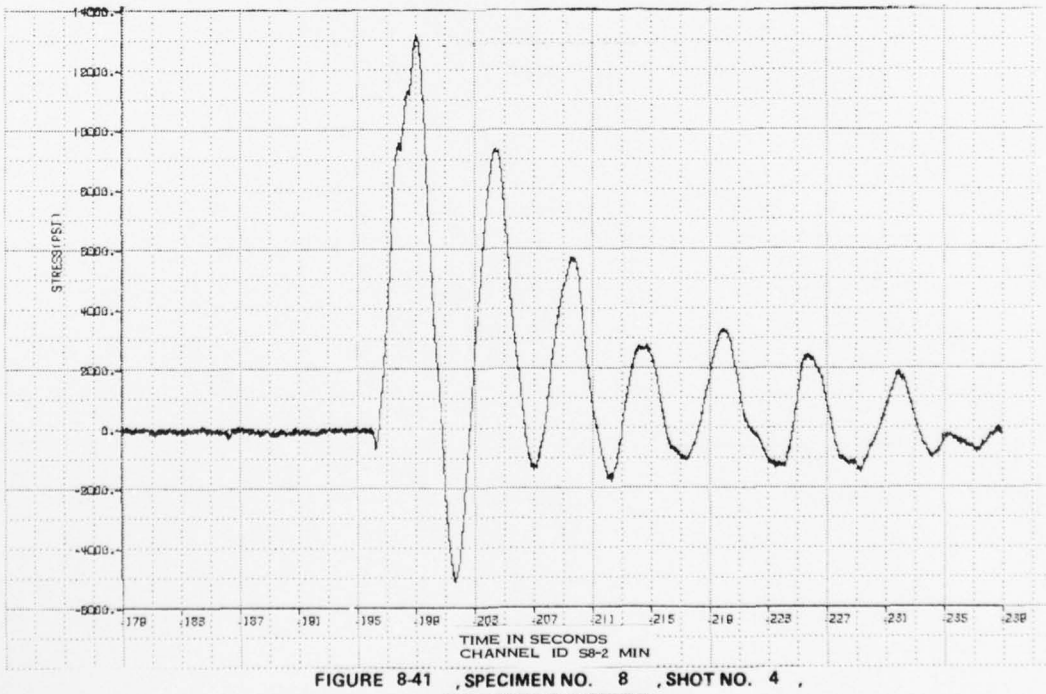


FIGURE 8-41 , SPECIMEN NO. 8 , SHOT NO. 4 ,
STRESS TIME HISTORY

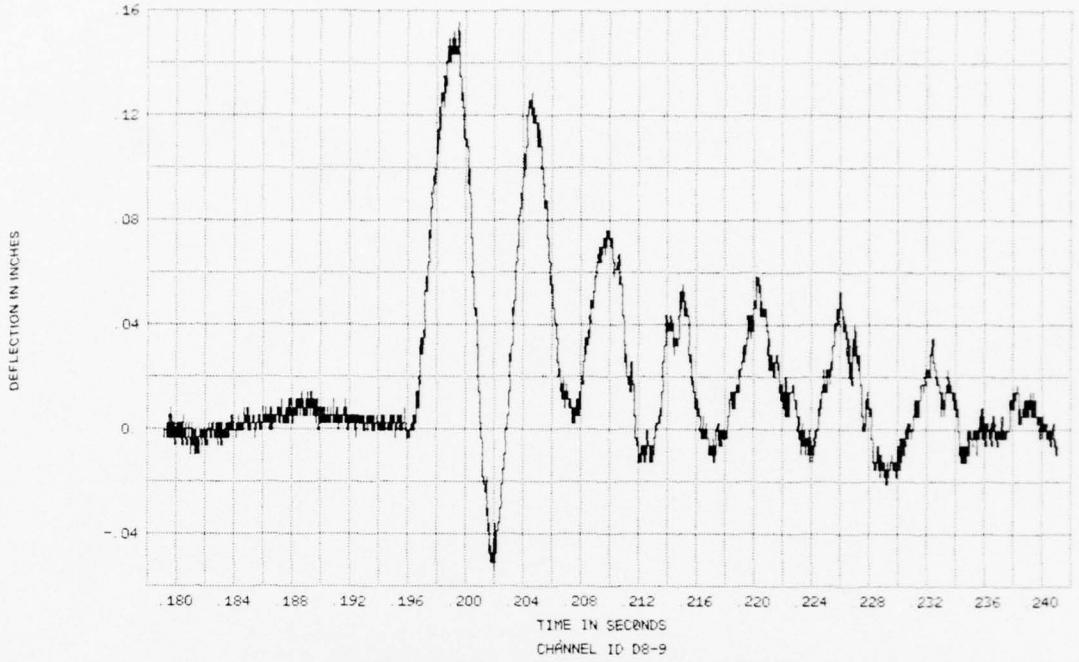


FIGURE 8-42 , SPECIMEN NO. 8 , SHOT NO. 4 ,
DEFLECTION TIME HISTORY

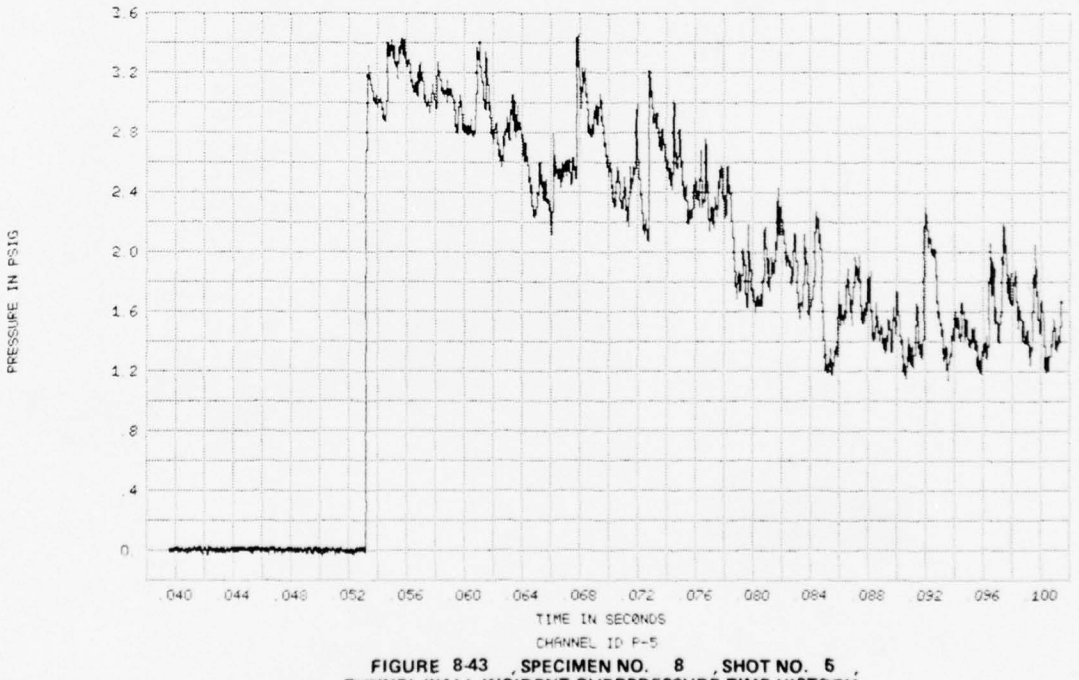


FIGURE 8-43 , SPECIMEN NO. 8 , SHOT NO. 5 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

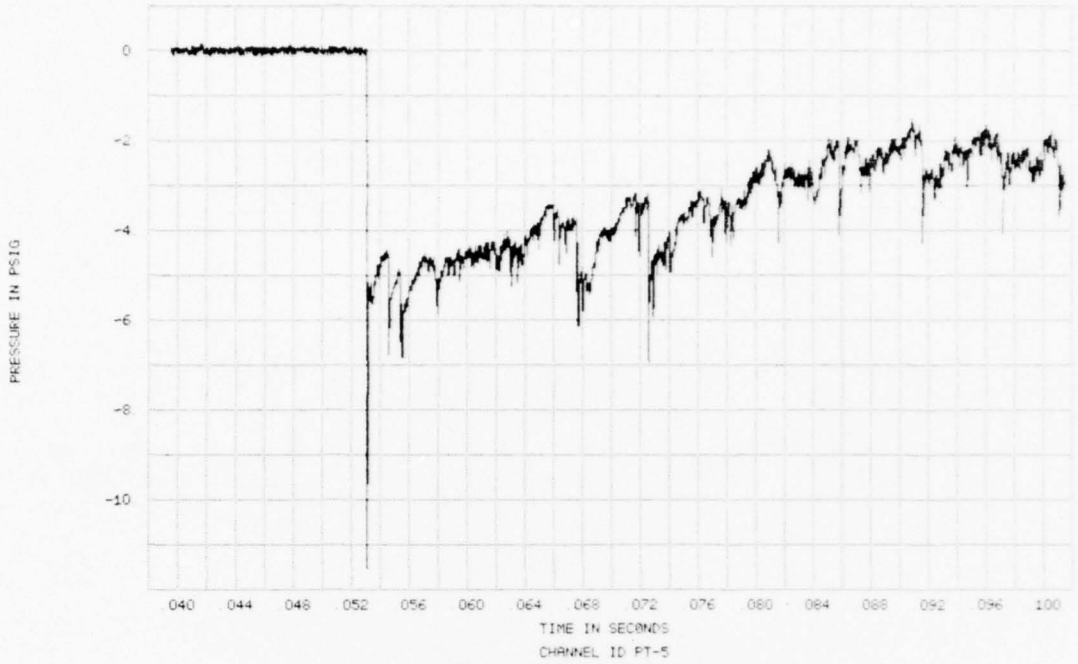


FIGURE 8-44 , SPECIMEN NO. 8 , SHOT NO. 5 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

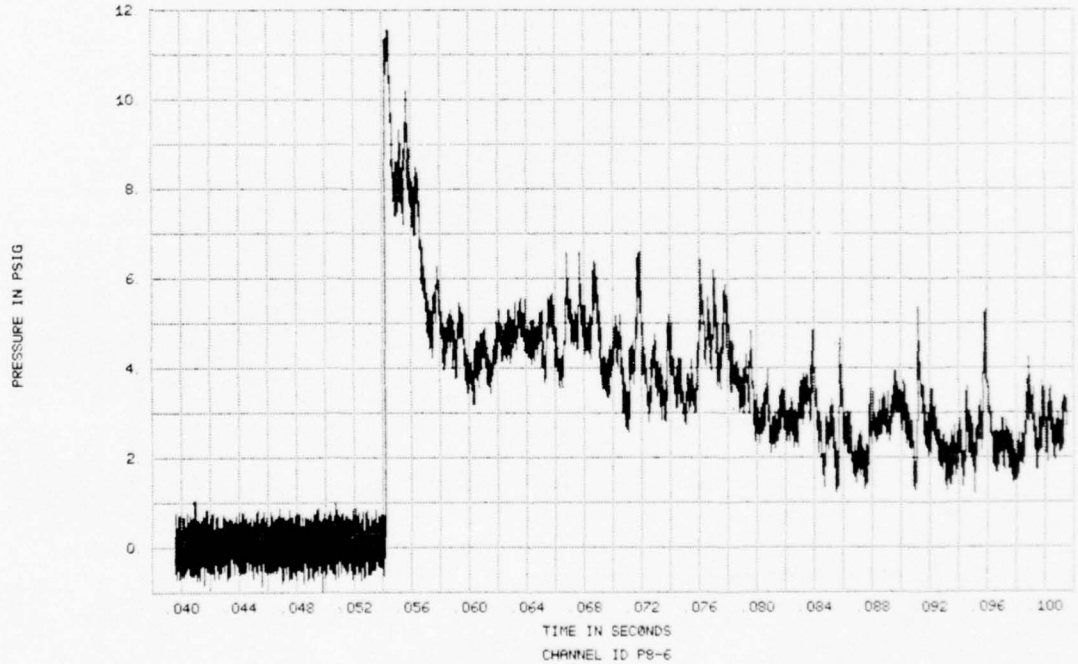


FIGURE 8-45 , SPECIMEN NO. 8 , SHOT NO. 5 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

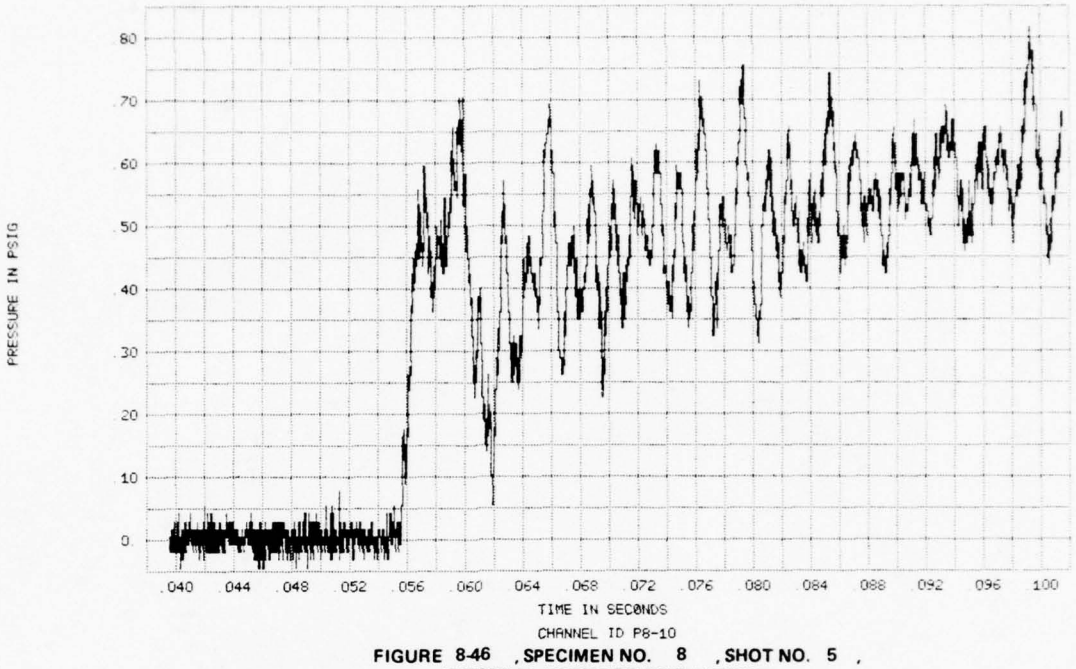


FIGURE 8-46 , SPECIMEN NO. 8 , SHOT NO. 5 ,
INTERNAL PRESSURE TIME HISTORY

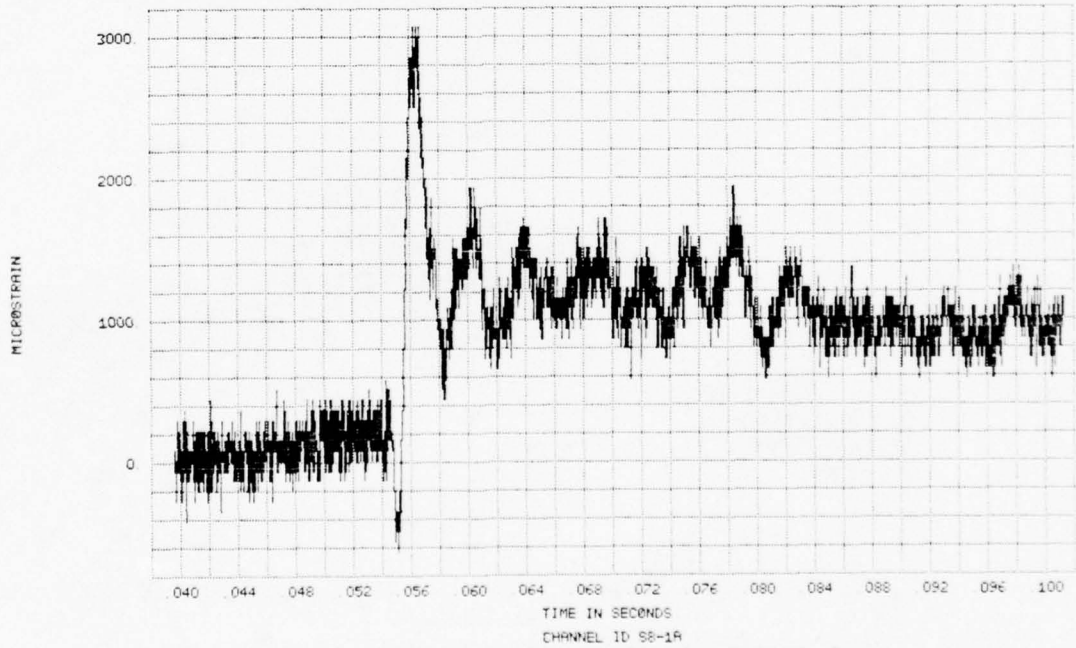


FIGURE 8-47 , SPECIMEN NO. 8 , SHOT NO. 5 ,
STRAIN TIME HISTORY

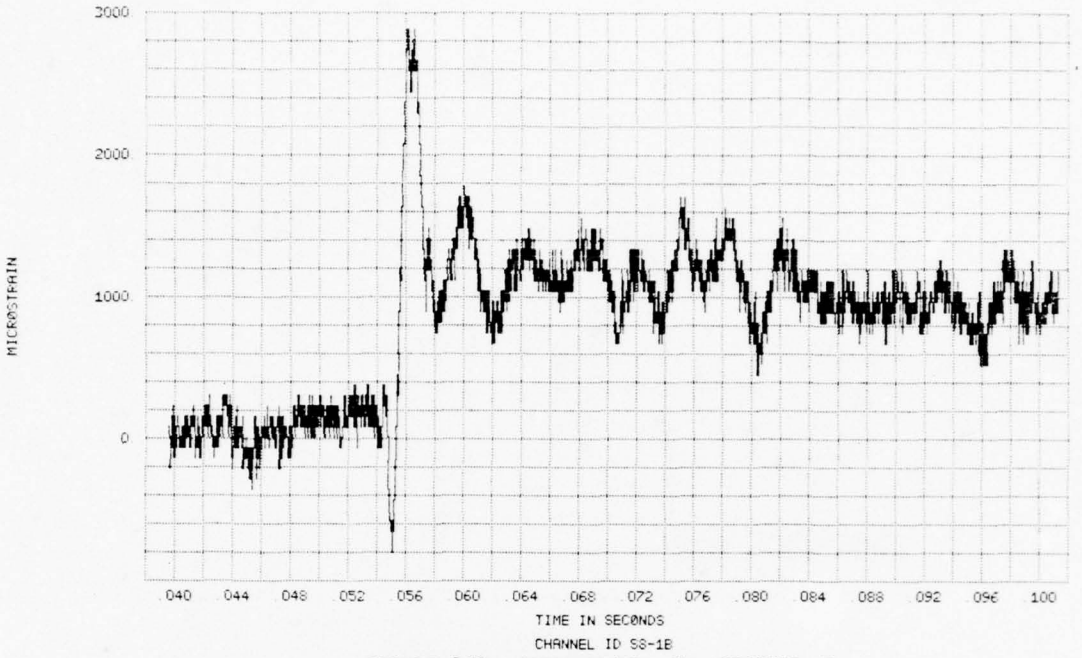


FIGURE 8-48 , SPECIMEN NO. 8 , SHOT NO. 5 , STRAIN TIME HISTORY

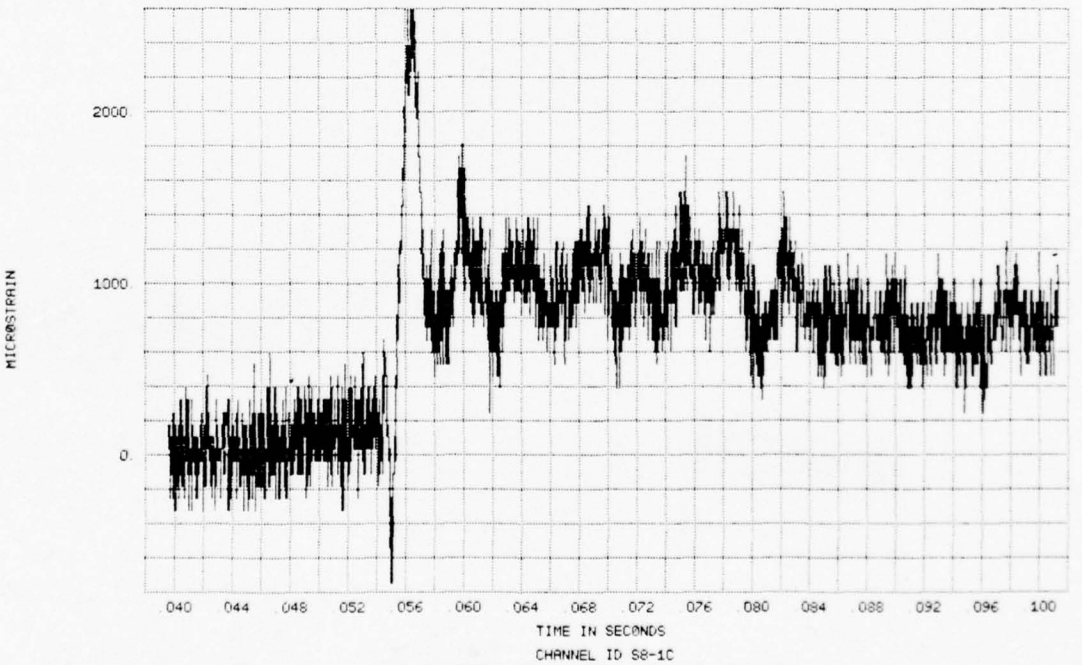


FIGURE 8-49 , SPECIMEN NO. 8 , SHOT NO. 5 , STRAIN TIME HISTORY

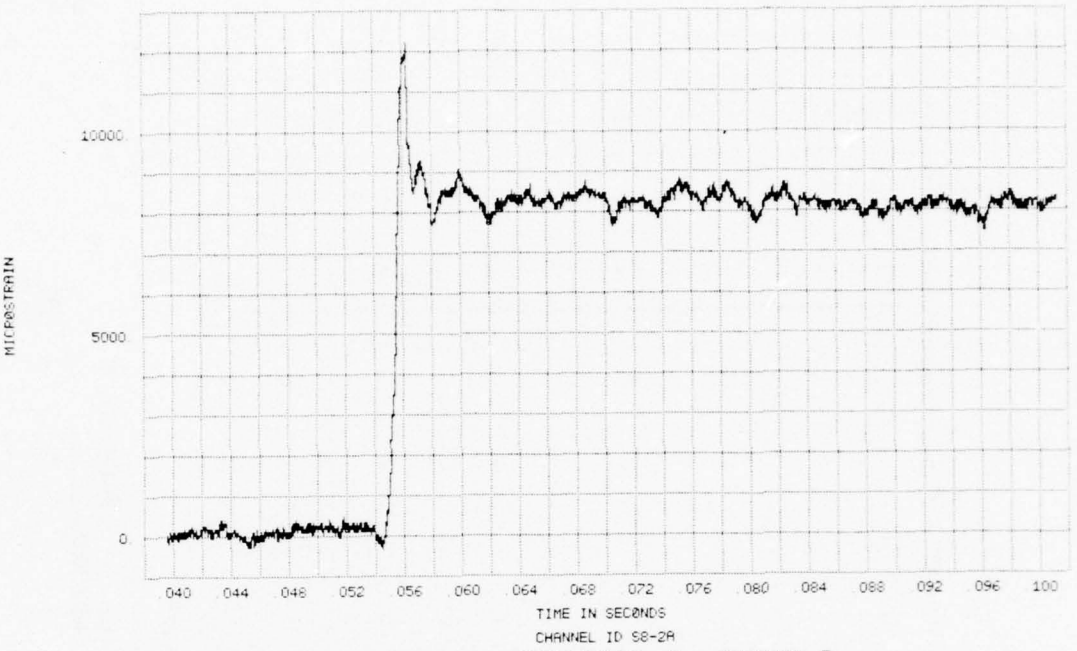


FIGURE 8-50 , SPECIMEN NO. 8 , SHOT NO. 5 ,
STRAIN TIME HISTORY

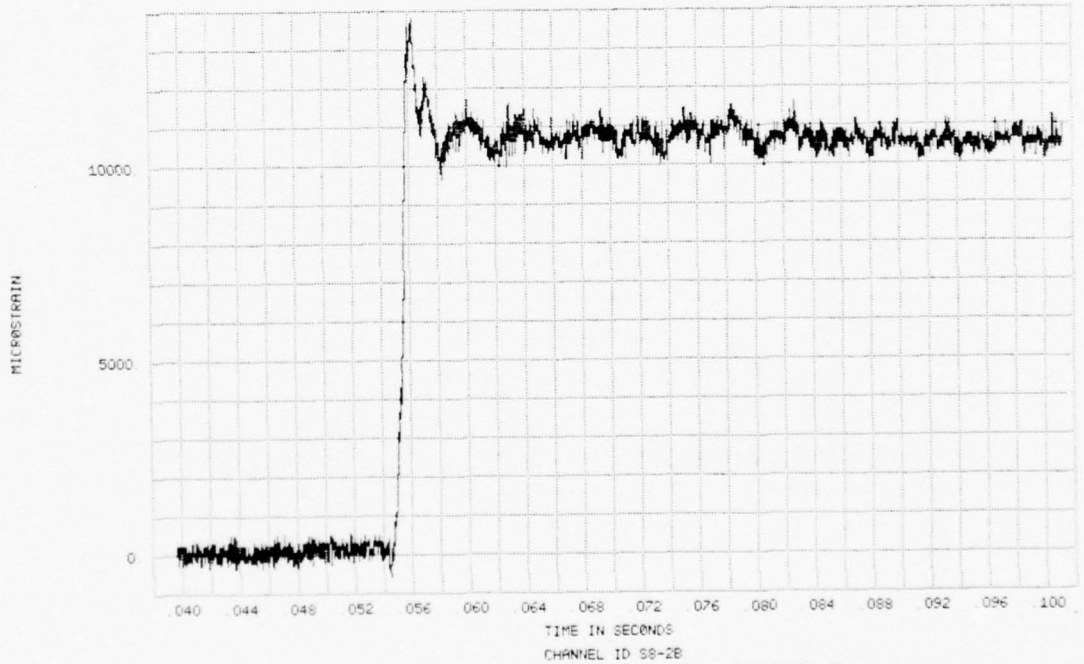


FIGURE 8-51 , SPECIMEN NO. 8 , SHOT NO. 5 ,
STRAIN TIME HISTORY

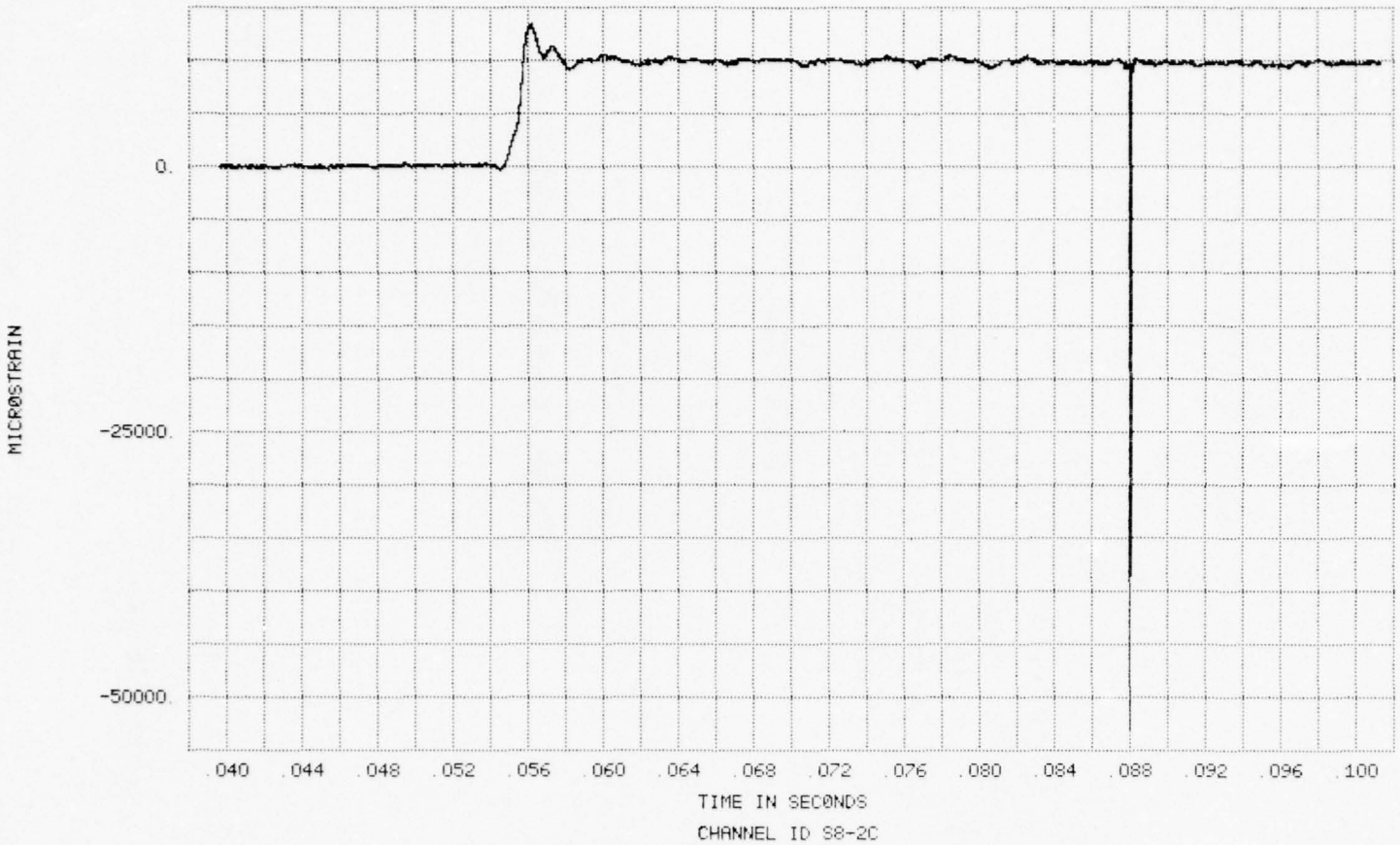
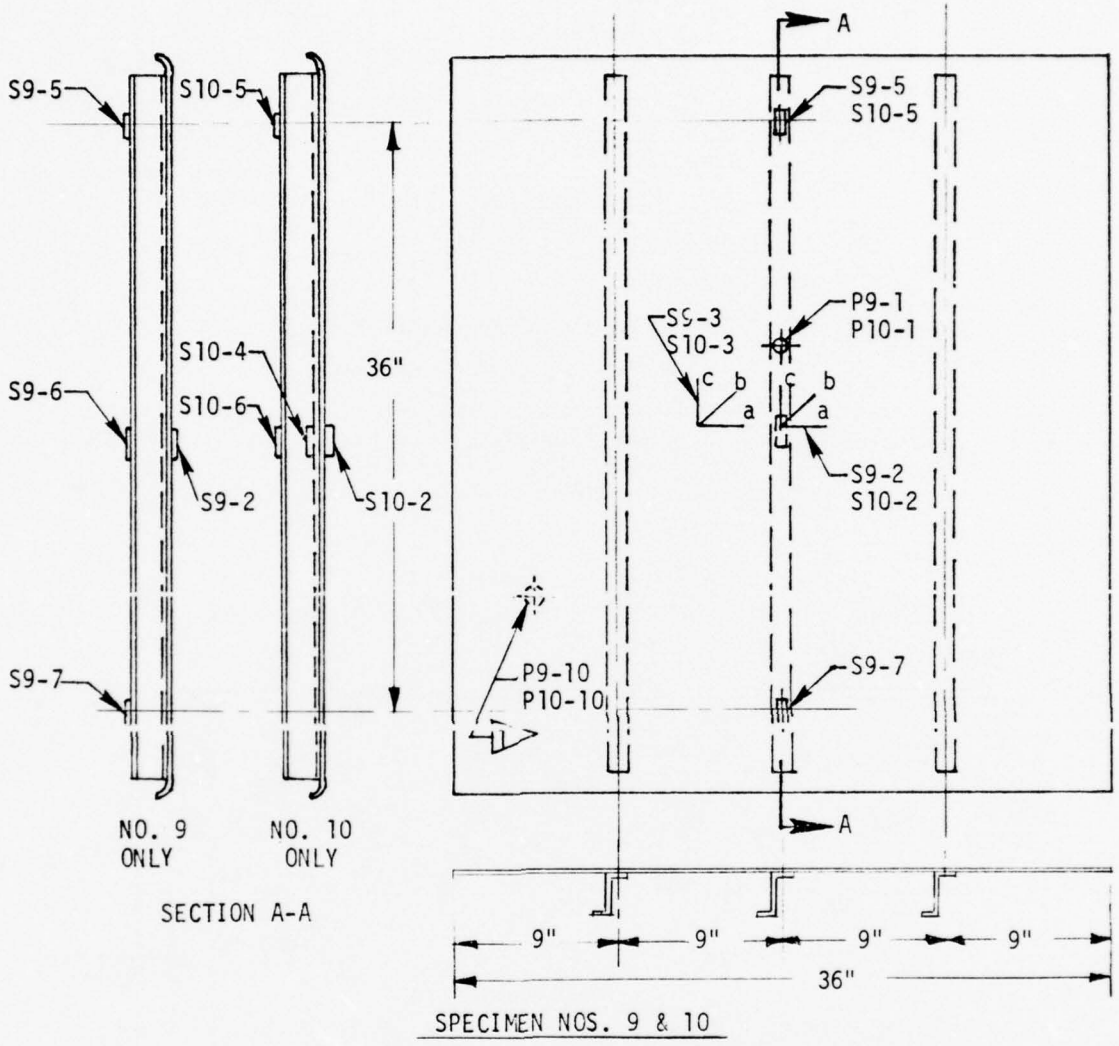


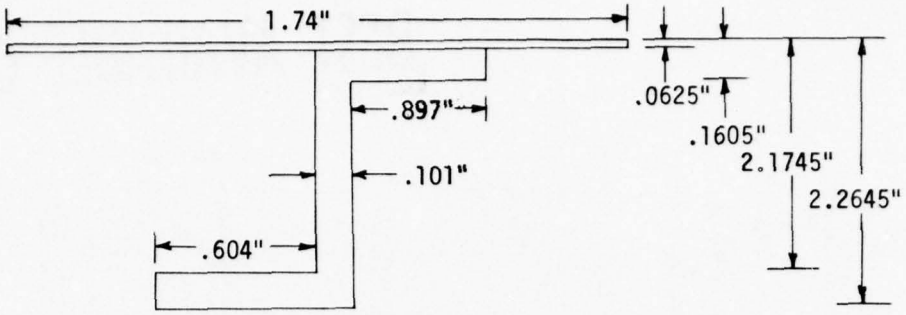
FIGURE 8-52 , SPECIMEN NO. 8 , SHOT NO. 5 , STRAIN TIME HISTORY

SPEC NOS. 9 & 10

BEST AVAILABLE COPY



1 ON BACK SIDE OF BOX HOLDING FIXTURE ONLY



SPECIMEN NO. 9

FLAT STIFFENED PANEL

STIFFENERS CLAMPED

STIFFENER MATERIAL - 2024-T3511 ALUMINUM ALLOY

DENSITY - .000259 lb-sec^2/in^4 (MIL-HDBK-5)

POISSON'S RATIO - .33

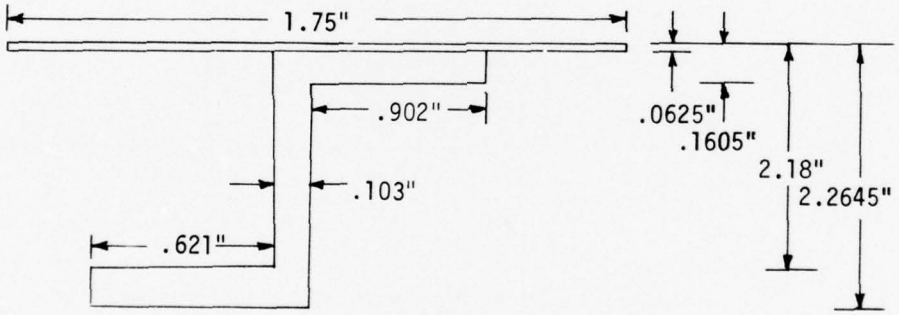
MODULUS OF ELASTICITY - 10.6 x 10^6 PSI

% ELONGATION - 22.0

F_{ty} - 52,230 PSI

F_{tu} - 66,320 PSI

STRESS-STRAIN DATA BASED ON COUPON TESTS & MIL-HDBK-5



SPECIMEN NO. 10

FLAT STIFFENED PANEL

STIFFENERS PINNED

STIFFENER MATERIAL - 2024-T3511 ALUMINUM ALLOY

DENSITY - .000259 lb-sec^2/in^4 (MIL-HDBK-5)

POISSON'S RATIO - .33

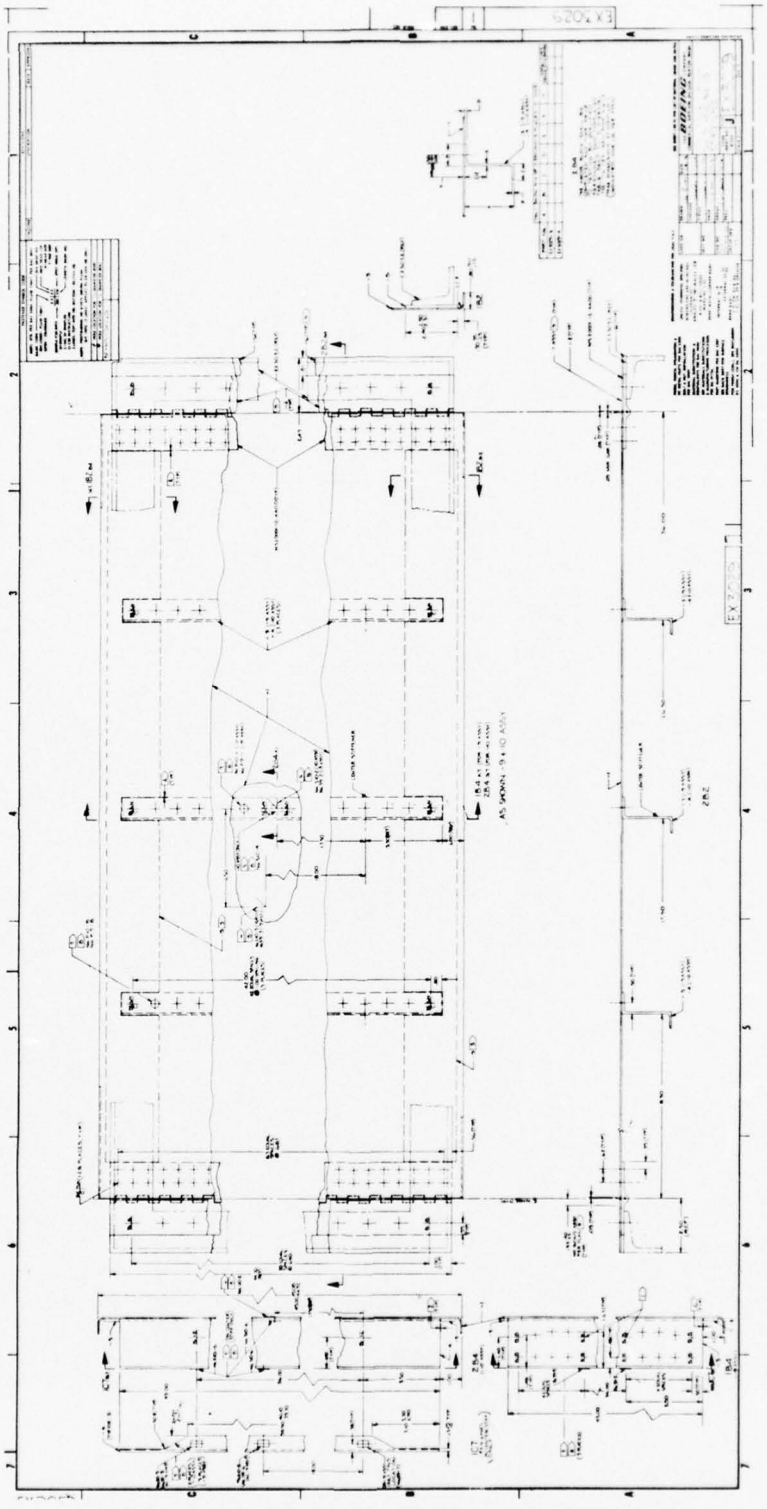
MODULUS OF ELASTICITY - 10.8 x 10^6 PSI

% ELONGATION - 18.0

F_{ty} - 52,710 PSI

F_{tu} - 67,310 PSI

STRESS-STRAIN DATA BASED ON COUPON TESTS



BEST AVAILABLE COPY

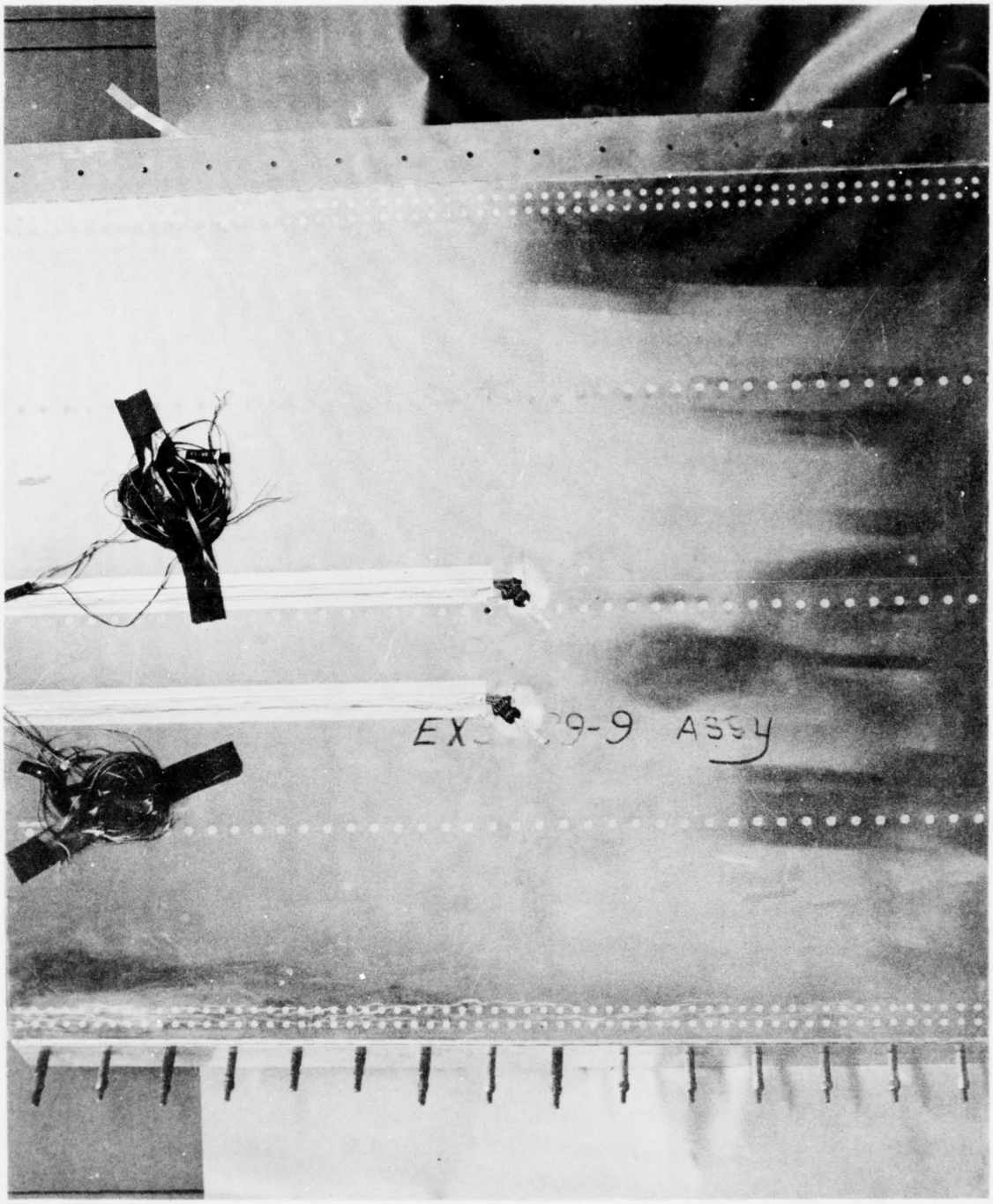


FIGURE 9-1 - SPECIMEN NO. 9 - INSTRUMENTATION - FRONT

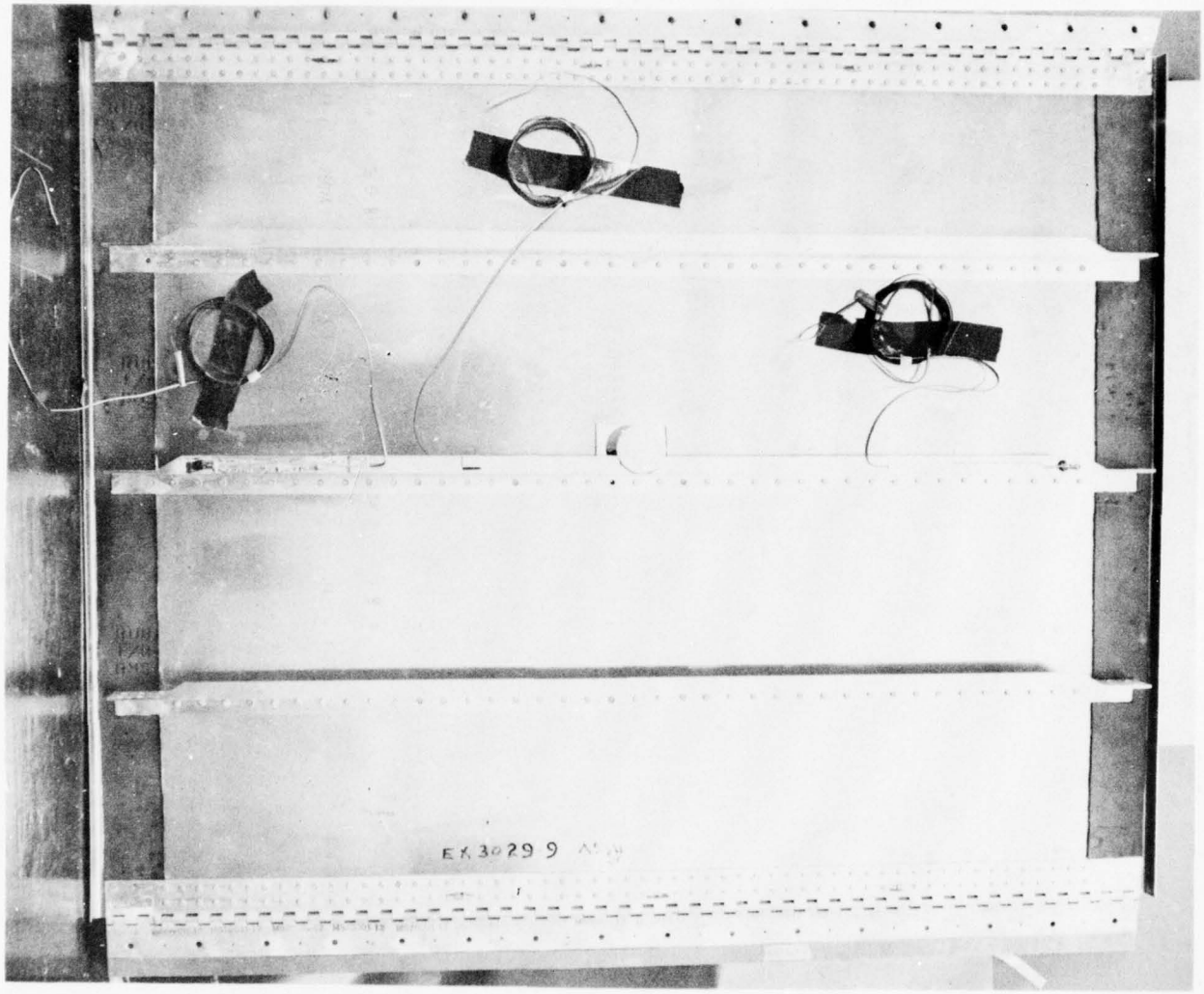


FIGURE 9-2 - SPECIMEN NO. 9 - INSTRUMENTATION - BACK

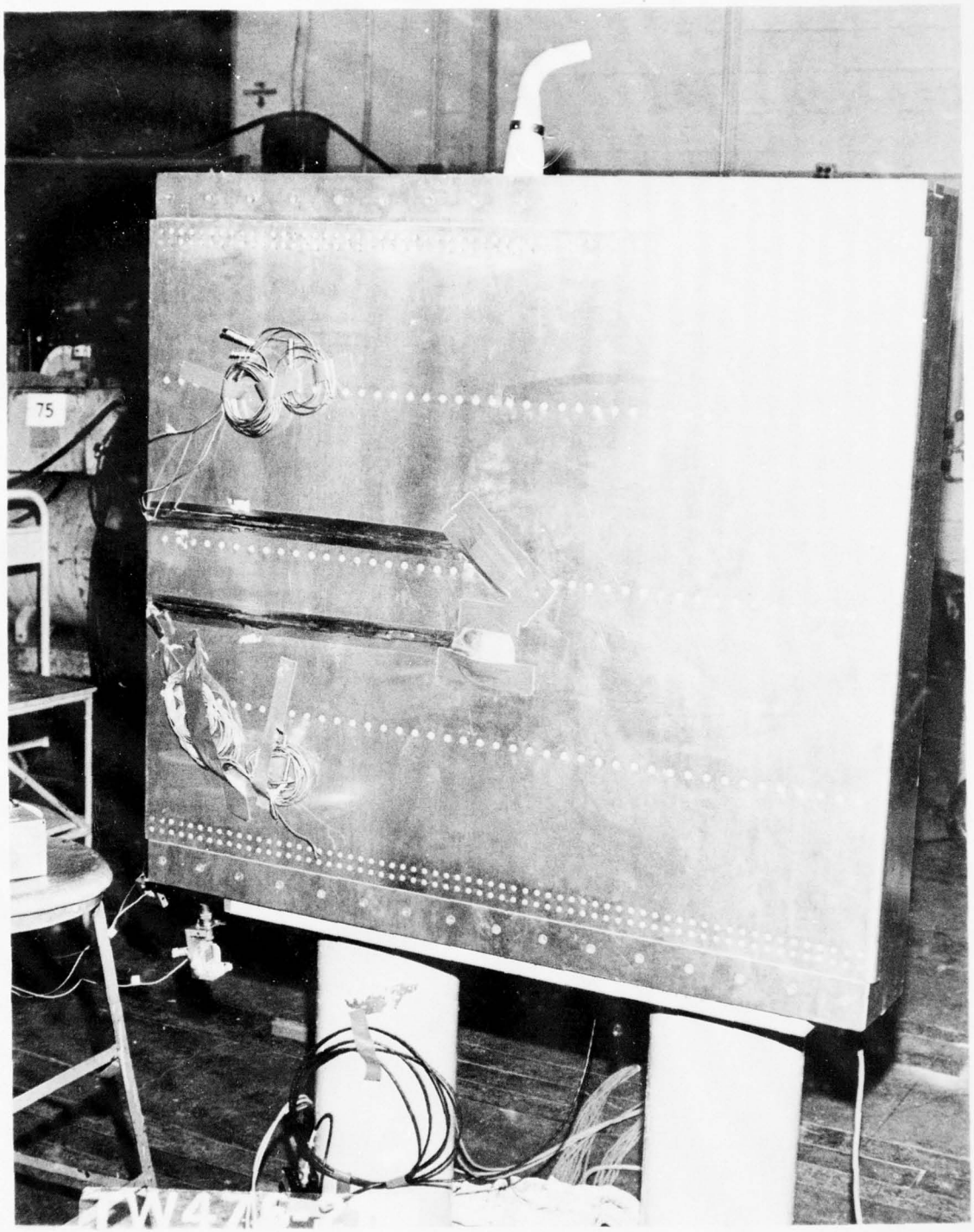


FIGURE 10-1 - SPECIMEN NO. 10 - TEST SET-UP



FIGURE 10-2 - SPECIMEN NO. 10 - INSTRUMENTATION - FRONT

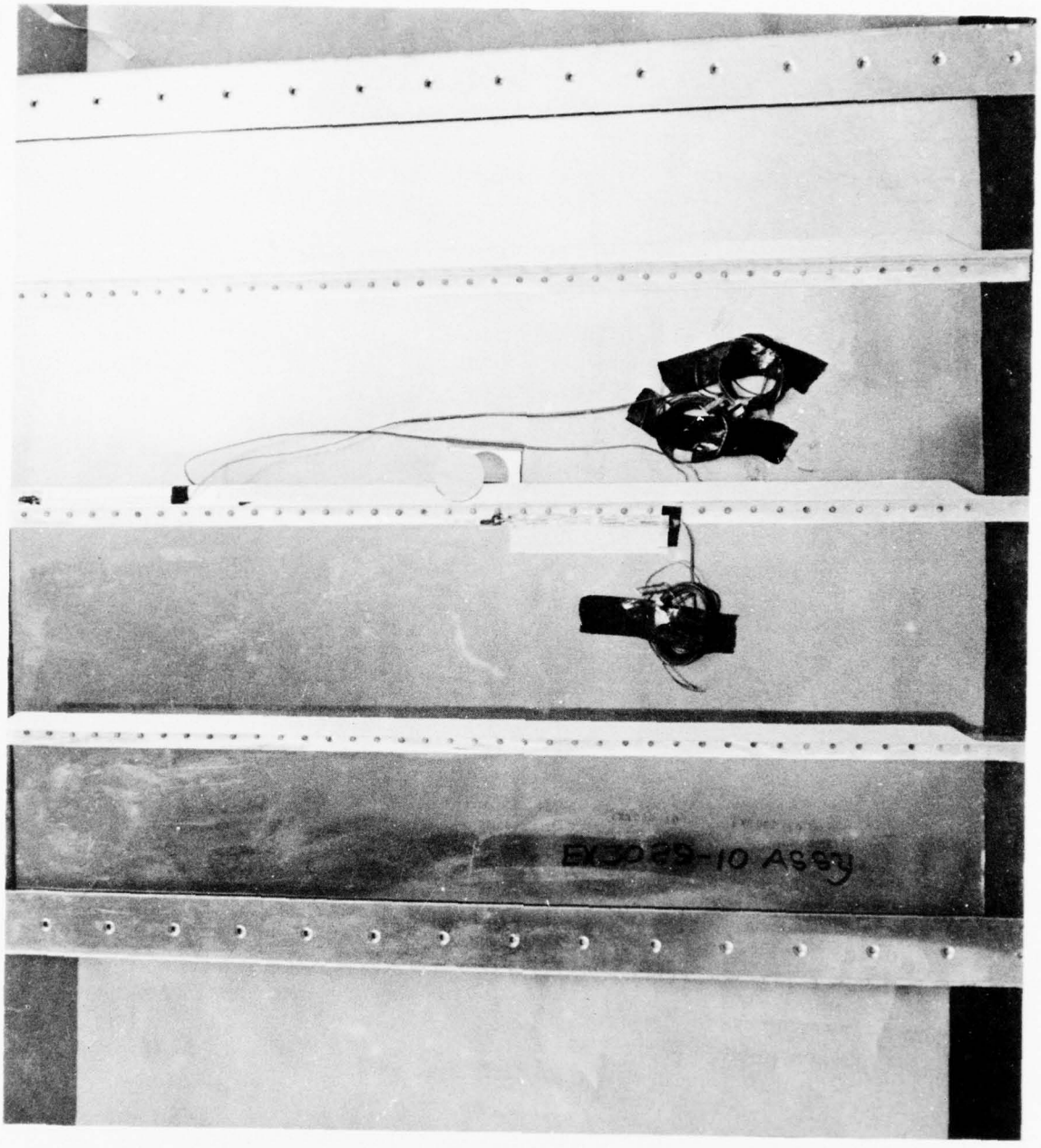


FIGURE 10-3 - SPECIMEN NO. 10 - INSTRUMENTATION - BACK

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.9 - STATIC ANALYSIS - PRESS = 4.0 PSI - MAY'76 - SYRING   GP   1
          1          0                                                     GP   2
0.0        0.1        0.01       0.0                                      GP   3
0.0        0.0        0.0        0.0                                      GP   4
         15         15                                                     GP   5
100000.                                                                   GP   7
                                                                          GP   8
          2          0                                                     GP   9
          2                                                                GP  10
          0          0                                                     GP  12
          0          0                                                     GP  15
          2          2                                                     GP  18
0.0        0.0                                                            GP  19
0.0       42.0                                                            GP  19
-42.0      0.0                                                            GP  20
-42.0     42.0                                                            GP  20
          0                                                               GP  21
          4          6          1                                         GP  25
-21.0      0.0       21.0                                                 GP  26
-4.0                                                                      GP  30
          2          2          5          1          1          0       GPB   1
         18          4          4                                         GPB   2
0.0        0.0                                                            GPB   3
1.0        0.0                                                            GPB   4
2.0        0.0                                                            GPB   4
3.0        0.0                                                            GPB   4
4.0        0.0                                                            GPB   4
5.0        0.0                                                            GPB   4
6.0        0.0                                                            GPB   4
7.0        0.0                                                            GPB   4
8.0        0.0                                                            GPB   4
9.0        0.0                                                            GPB   4
10.0       0.0                                                            GPB   4
11.0       0.0                                                            GPB   4
12.0       0.0                                                            GPB   4
13.0       0.0                                                            GPB   4
14.0       0.0                                                            GPB   4
15.0       0.0                                                            GPB   4
16.0       0.0                                                            GPB   4
17.0       0.0                                                            GPB   4
17.5       0.0                                                            GPB   4
18.0       0.0                                                            GPB   7
          0                                                               GPB   8
          1          1          1          1                              GPB  12
.000259    .000259    .000259    .000259                                  GPB  13
9.0                                                                       GPB  14
0.0625                                                                    GPB  15
1.74                                                                      GPB  16
          3                                                               GPB  17
.00386     38618.                                                         GPB  18
.0062      44000.                                                         GPB  18
.0092      49000.                                                         GPB  18
          3                                                               GPB  19
.00532     53230.                                                         GPB  20
.007       53500.                                                         GPB  20
.0094      54000.                                                         GPB  20
0.093                                                                     GPB  15
0.998                                                                     GPB  15
```


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NOVA-2 DATA DECK LISTING (CONTINUED)

```
                3                                                       GPB 17
.003719      39419.                                                     GPB 18
.0059        50000.                                                     GPB 19
.0084        54000.                                                     GPB 19
                3                                                       GPB 19
.004927      52230.                                                     GPB 20
.006         56000.                                                     GPB 20
.0088        58000.                                                     GPB 20
2.014                                                                   GPB 15
0.101                                                                   GPB 16
                3                                                       GPB 17
.003719      39419.                                                     GPB 18
.0059        50000.                                                     GPB 18
.0084        54000.                                                     GPB 18
                3                                                       GPB 19
.004927      52230.                                                     GPB 20
.006         56000.                                                     GPB 20
.0088        58000.                                                     GPB 20
0.090                                                                   GPB 15
0.705                                                                   GPB 16
                3                                                       GPB 17
.003719      39419.                                                     GPB 18
.0059        50000.                                                     GPB 18
.0084        54000.                                                     GPB 18
                3                                                       GPB 19
.004927      52230.                                                     GPB 20
.006         56000.                                                     GPB 20
.0088        58000.                                                     GPB 20
.000001      .000001      1.0                                           GPB 22
                                                                        GP 32
```

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NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.10 - STATIC ANALYSIS - PRESS = 4.0 PSI - MAY'76 - SYRING  GP  1
          1           0                                                    GP  2
0.0        0.1         0.01        0.0                                     GP  3
0.0        0.0         0.0         0.0                                     GP  4
         15          15                                                    GP  5
100000.                                                                    GP  7
                                                                           GP  8
          2           0                                                    GP  9
          2                                                                GP 10
          0           0                                                    GP 12
          0           0                                                    GP 15
          2           2                                                    GP 16
0.0        0.0                                                             GP 19
0.0       42.0                                                             GP 19
-42.0      0.0                                                             GP 20
-42.0     42.0                                                             GP 20
          0                                                                GP 21
          4           6           1                                        GP 25
-21.0      0.0         21.0                                                GP 26
-4.0                                                                       GP 30
          2           3           3           1           1           0    GPB  1
         35           4           4                                        GPB  2
0.0        0.0                                                             GPB  5
1.0        0.0                                                             GPB  5
2.0        0.0                                                             GPB  6
3.0        0.0                                                             GPB  6
4.0        0.0                                                             GPB  5
5.0        0.0                                                             GPB  6
6.0        0.0                                                             GPB  6
7.0        0.0                                                             GPB  6
8.0        0.0                                                             GPB  6
9.0        0.0                                                             GPB  6
10.0       0.0                                                             GPB  6
11.0       0.0                                                             GPB  5
12.0       0.0                                                             GPB  5
13.0       0.0                                                             GPB  6
14.0       0.0                                                             GPB  6
15.0       0.0                                                             GPB  6
16.0       0.0                                                             GPB  6
17.0       0.0                                                             GPB  6
18.0       0.0                                                             GPB  6
19.0       0.0                                                             GPB  6
20.0       0.0                                                             GPB  6
21.0       0.0                                                             GPB  6
22.0       0.0                                                             GPB  6
23.0       0.0                                                             GPB  6
24.0       0.0                                                             GPB  6
25.0       0.0                                                             GPB  6
26.0       0.0                                                             GPB  6
27.0       0.0                                                             GPB  6
28.0       0.0                                                             GPB  6
29.0       0.0                                                             GPB  6
30.0       0.0                                                             GPB  6
31.0       0.0                                                             GPB  5
32.0       0.0                                                             GPB  5
33.0       0.0                                                             GPB  6
34.0       0.0                                                             GPB  6
35.0       0.0                                                             GPB  6
```


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NOVA-2 DATA DECK LISTING (CONTINUED)

```
36.0          0.0                                                    GPB  7
              0                                                      GPB  8
              1              1              1              1        GPB 12
.000259       .000259        .000259        .000259                GPB 13
9.0                                                                  GPB 14
0.0625                                                               GPB 15
1.74                                                                 GPB 16
              3                                                      GPB 17
.00404        39626.                                                 GPB 18
.0062         44000.                                                 GPB 18
.0092         49000.                                                 GPB 18
              3                                                      GPB 19
.00557        54620.                                                 GPB 20
.007          55000.                                                 GPB 20
.0094         56000.                                                 GPB 20
0.098                                                                GPB 15
1.005                                                                GPB 16
              3                                                      GPB 17
.00368        39781.                                                 GPB 18
.0059         50000.                                                 GPB 18
.0084         54000.                                                 GPB 18
              3                                                      GPB 19
.00488        52710.                                                 GPB 20
.006          56000.                                                 GPB 20
.0083         58000.                                                 GPB 20
2.0195                                                               GPB 15
0.103                                                                GPB 16
              3                                                      GPB 17
.00368        39781.                                                 GPB 18
.0059         50000.                                                 GPB 18
.0084         54000.                                                 GPB 18
              3                                                      GPB 19
.00488        52710.                                                 GPB 20
.006          56000.                                                 GPB 20
.0088         58000.                                                 GPB 20
0.0845                                                               GPB 15
0.724                                                                GPB 16
              3                                                      GPB 17
.00368        39781.                                                 GPB 18
.0059         50000.                                                 GPB 18
.0084         54000.                                                 GPB 18
              3                                                      GPB 19
.00488        52710.                                                 GPB 20
.006          56000.                                                 GPB 20
.0088         58000.                                                 GPB 20
.000001       .000001        1.0                                     GPB 22
                                                                      GP  32
```

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TABLE XXXVI

STATIC TEST STRESSES - SPECIMEN NO. 9
(STRESSES GIVEN IN PSI)

STRAIN GAUGE	STATIC PRESSURE (PSI)								
	1.2	2.4	3.6	4.2	4.8	5.1	5.4	5.7	6.0
S9-2	5891.	11261.	15309.	16919.	18458.	19084.	19738.	20392.	21055.
S9-3	-5971.	-9875.	-11599.	-12170.	-12636.	-12797.	-12922.	-13084.	-13206.
S9-5	-5194.	-10282.	-17543.	-18073.	-20723.	-22101.	-23426.	-24804.	-25959.
S9-6	2777.	5660.	8798.	10324.	11978.	12858.	13833.	14819.	15699.
S9-7	-4971.	-10335.	-15783.	-18285.	-21083.	-22366.	-23479.	-24274.	-25133.

TABLE XXXVII

STATIC TEST DISPLACEMENTS - SPECIMEN NO. 9
(DISPLACEMENT MEASURED AT CENTER OF PANEL)

	STATIC PRESSURE (PSI)								
	1.2	2.4	3.6	4.2	4.8	5.1	5.4	5.7	6.0
DISPLACEMENT (INCHES)	.021	.041	.062	.072	.085	.092	.098	.110	.120

TABLE XXXVIII

STATIC TEST STRESSES - SPECIMEN NO. 10
(STRESSES GIVEN IN PSI)

STRAIN GAUGE	STATIC PRESSURE (PSI)								
	1.2	2.4	3.6	4.2	4.8	5.1	5.4	5.7	6.0
S10-2	5126.	10927.	15072.	16814.	18079.	18621.	19107.	19623.	20033.
S10-3	-5681.	-9288.	-11716.	-12575.	-13192.	-13358.	-13483.	-13621.	-13756.
S10-4	-821.	-2268.	-3726.	-4439.	-5281.	-5497.	-5832.	-6156.	-6577.
S10-5	-670.	-1156.	-1523.	-1868.	-2041.	-2084.	-2290.	-2376.	-2592.
S10-6	5789.	11794.	17906.	21060.	24311.	25834.	27302.	28890.	30510.

TABLE XXXIX

STATIC TEST DISPLACEMENTS - SPECIMEN NO. 10
(DISPLACEMENT MEASURED AT CENTER OF PANEL)

	STATIC PRESSURE (PSI)								
	1.2	2.4	3.6	4.2	4.8	5.1	5.4	5.7	6.0
DISPLACEMENT (INCHES)	.053	.103	.149	.173	.197	.209	.221	.233	.245

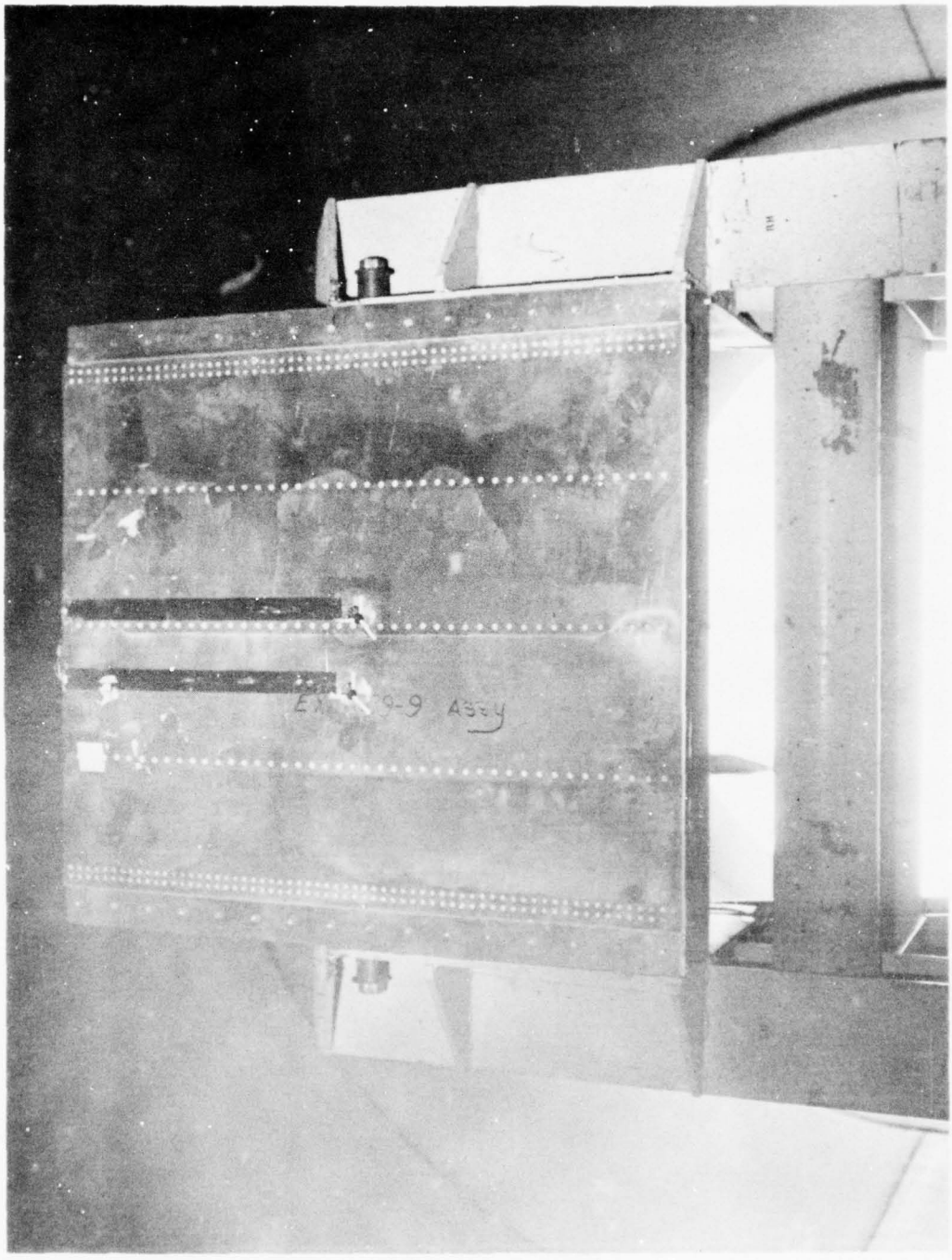


FIGURE 9-3 - SPECIMEN NO. 9 - SHOCK TEST SET-UP

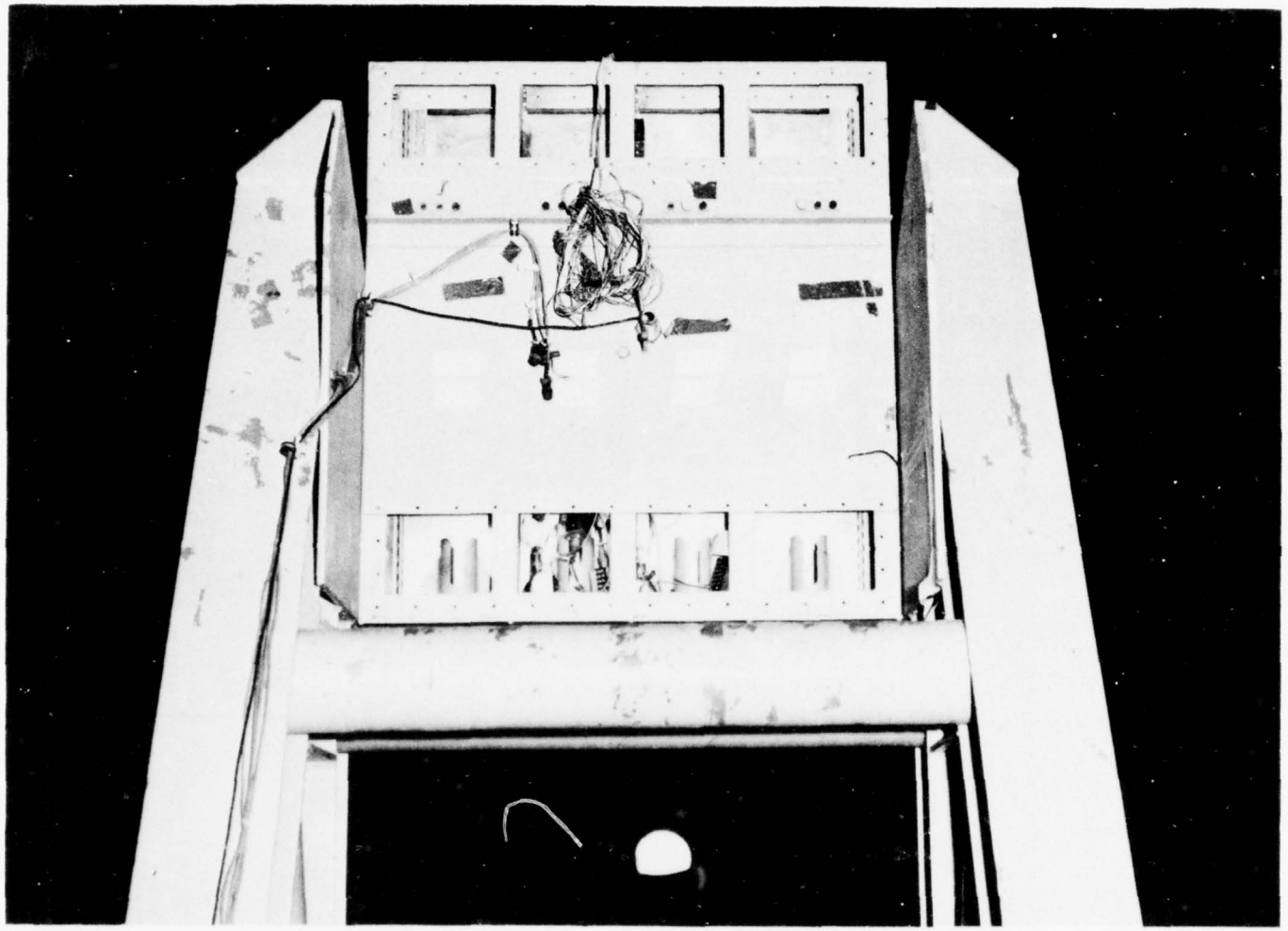


FIGURE 9-4 - SPECIMEN NO. 9 - SHOCK TEST SET-UP SHOWING ACCESS IN REAR OF HOLDING FIXTURE

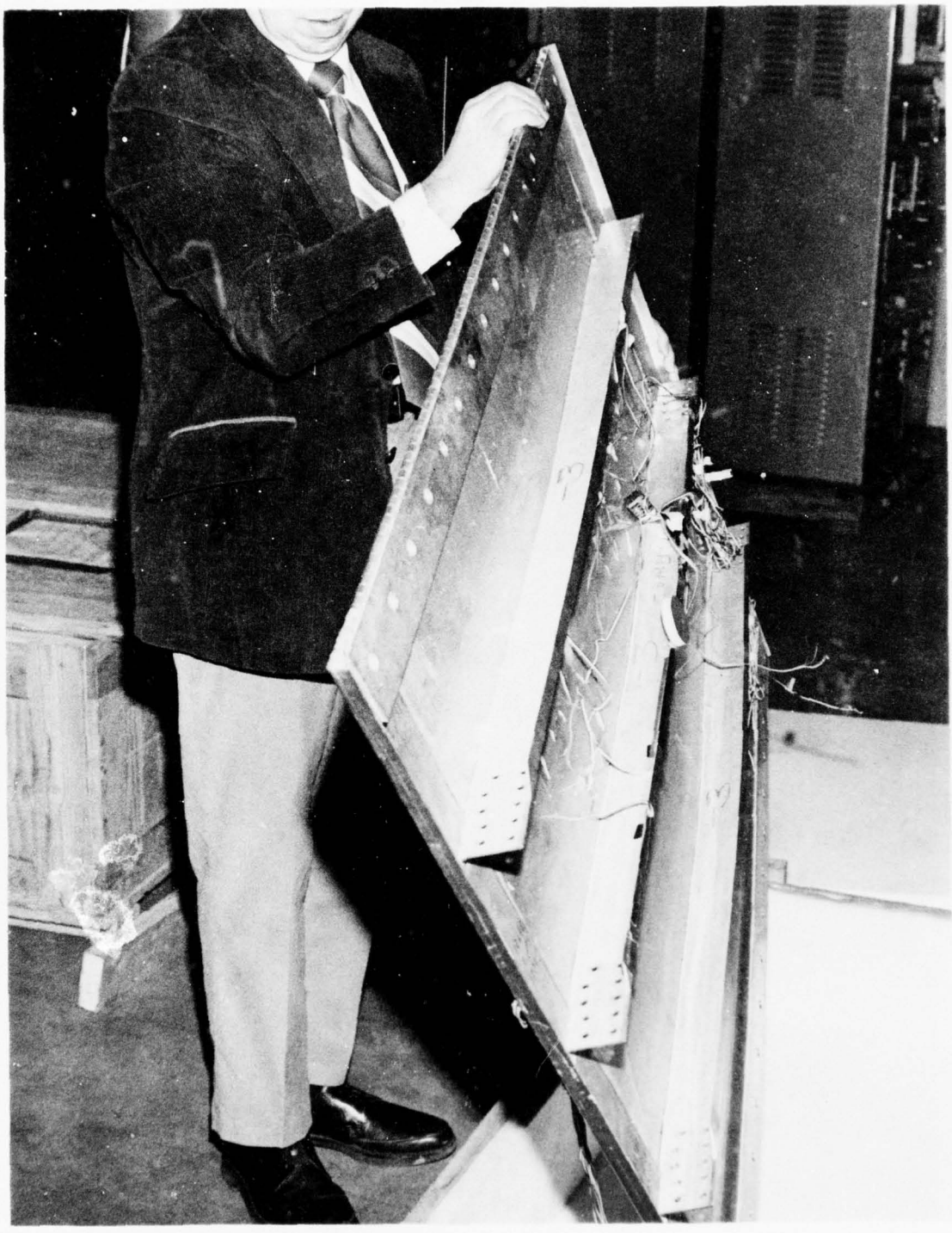


FIGURE 9-5 - SPECIMEN NO. 9 - SPECIMEN AFTER SHOCK TEST

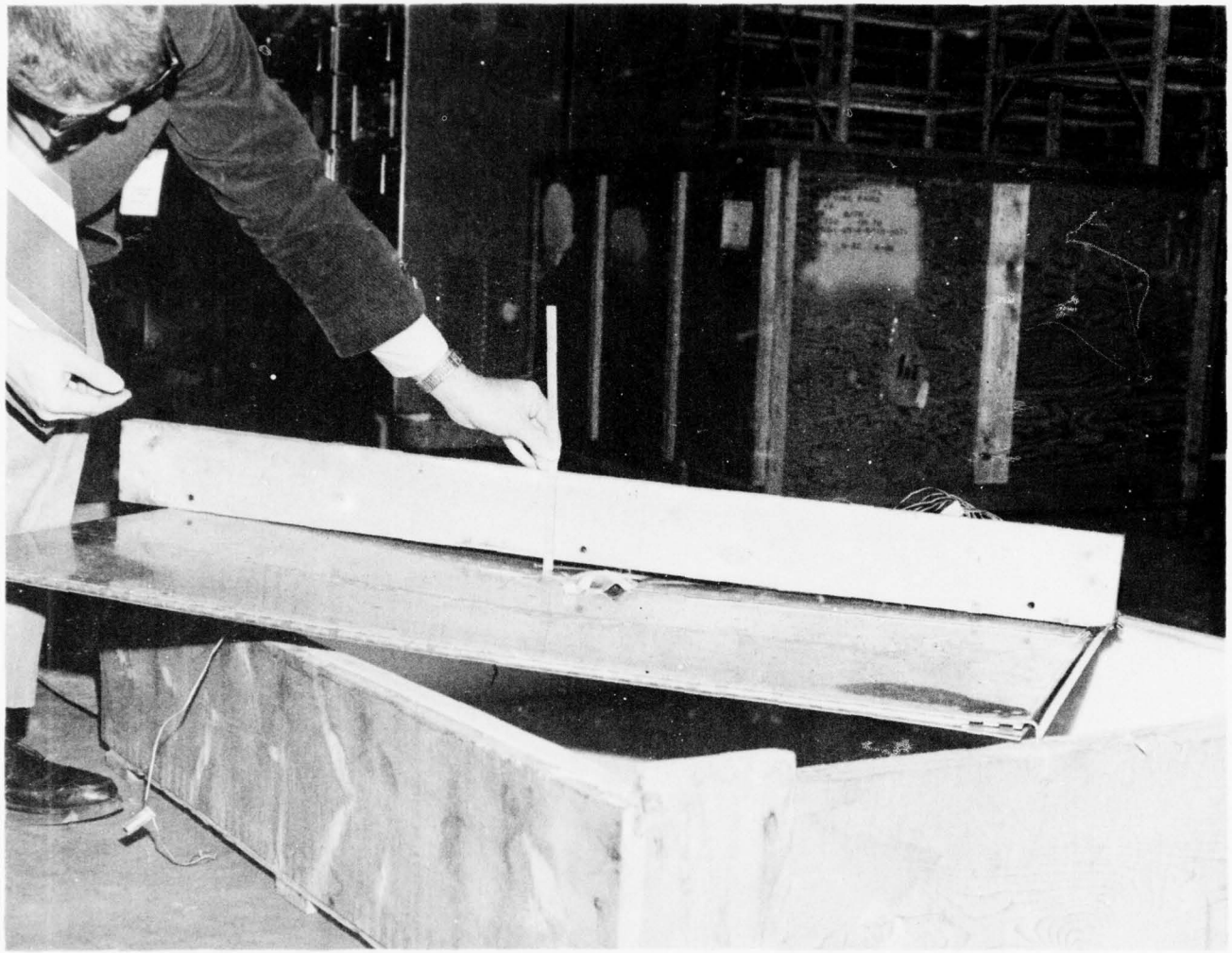


FIGURE 9-6 - SPECIMEN NO. 9 - INDICATION OF SHOCK TEST PERMANENT DEFORMATION

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.9 -DYNAMIC ANALYSIS - ITERATIVE TPD SOLUTION                    GP  1
          1           0                                                          GP  2
5000.      0.001       0.02       0.0                                          GP  3
0.0        0.0         0.0        0.0                                          GP  4
         15          15                                                         GP  5
500.0                                                                           GP  7
                                                                                GP  8
          2           0                                                         GP  9
          0           1                                                         GP 10
0.5                                                                             GP 11
          0           0                                                         GP 12
          0           0                                                         GP 15
          2           2                                                         GP 18
48.0       0.0                                                                  GP 19
20.0      96.0                                                                  GP 19
-60.0      0.0                                                                  GP 20
-70.0     96.0                                                                  GP 20
          0                                                                     GP 21
          4           6           1                                             GP 25
-21.0      0.0         21.0                                                     GP 25
0.0                                                                             GP 30
          2           2           5           1           1           1       GPB  1
         18           4           4                                           GPB  2
0.0        0.0                                                                GPB  3
1.0        0.0                                                                GPB  5
2.0        0.0                                                                GPB  6
3.0        0.0                                                                GPB  6
4.0        0.0                                                                GPB  6
5.0        0.0                                                                GPB  5
6.0        0.0                                                                GPB  5
7.0        0.0                                                                GPB  5
8.0        0.0                                                                GPB  5
9.0        0.0                                                                GPB  5
10.0       0.0                                                                GPB  5
11.0       0.0                                                                GPB  5
12.0       0.0                                                                GPB  5
13.0       0.0                                                                GPB  5
14.0       0.0                                                                GPB  5
15.0       0.0                                                                GPB  6
16.0       0.0                                                                GPB  6
17.0       0.0                                                                GPB  6
17.5       0.0                                                                GPB  5
18.0       0.0                                                                GPB  7
          0                                                                 GPB  8
          1           1           1           1                             GPB 12
.000259    .000259     .000259     .000259                                  GPB 13
9.0                                                                         GPB 14
0.0625                                                                      GPB 15
1.74                                                                        GPB 16
          3                                                                 GPB 17
.00386     38618.                                                           GPB 18
.0062      44000.                                                           GPB 18
.0092      49000.                                                           GPB 18
          3                                                                 GPB 19
.00532     53230.                                                           GPB 20
.0094      54000.                                                           GPB 20
0.18       69800.                                                           GPB 20
0.098                                                                       GPB 15
```

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```
0.998                                                                   GPB 16
            3                                                           GPB 17
.003719      39419.                                                     GPB 18
.0084        54000.                                                     GPB 19
.22          66320.0                                                    GPB 19
            3                                                           GPB 19
.004927      52230.                                                     GPB 20
.0088        58000.                                                     GPB 20
0.22         66320.                                                     GPB 20
2.014                                                                   GPB 15
0.101                                                                   GPB 16
            3                                                           GPB 17
.003719      39419.                                                     GPB 18
.0084        54000.                                                     GPB 19
.22          66320.0                                                    GPB 18
            3                                                           GPB 19
.004927      52230.                                                     GPB 20
.0088        58000.                                                     GPB 20
0.22         66320.                                                     GPB 20
0.090                                                                   GPB 15
0.705                                                                   GPB 16
            3                                                           GPB 17
.003719      39419.                                                     GPB 18
.0084        54000.                                                     GPB 19
.22          66320.0                                                    GPB 19
            3                                                           GPB 19
.004927      52230.                                                     GPB 20
.0088        58000.                                                     GPB 20
0.22         66320.                                                     GPB 20
0.0          0.005        25.0                                          GPB 22
                                                                        GP  32
```

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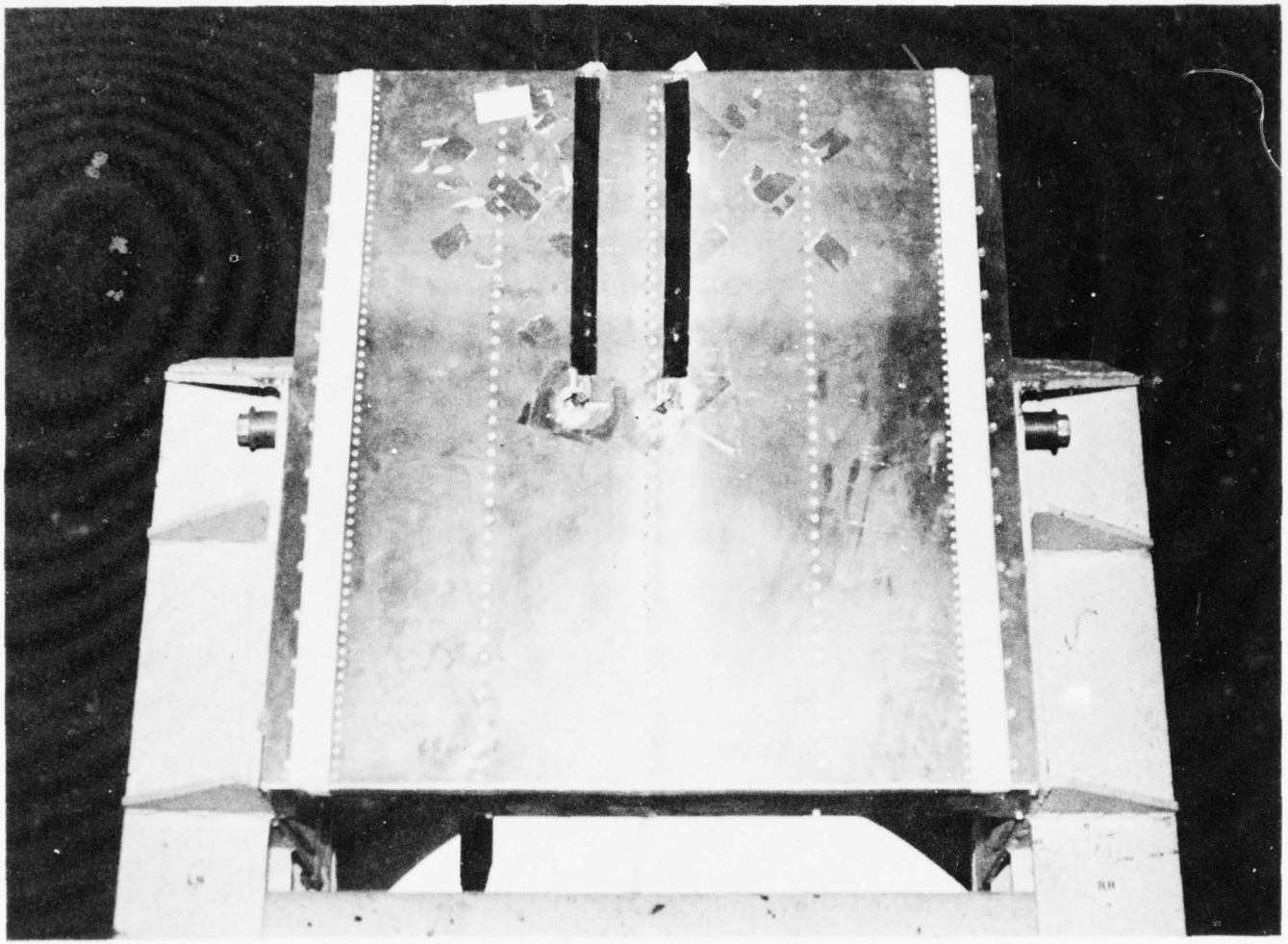


FIGURE 10-4 - SPECIMEN NO. 10 - SHOCK TEST SET-UP



FIGURE 10-5 - SPECIMEN NO. 10 - SPECIMEN AFTER SHOCK TEST

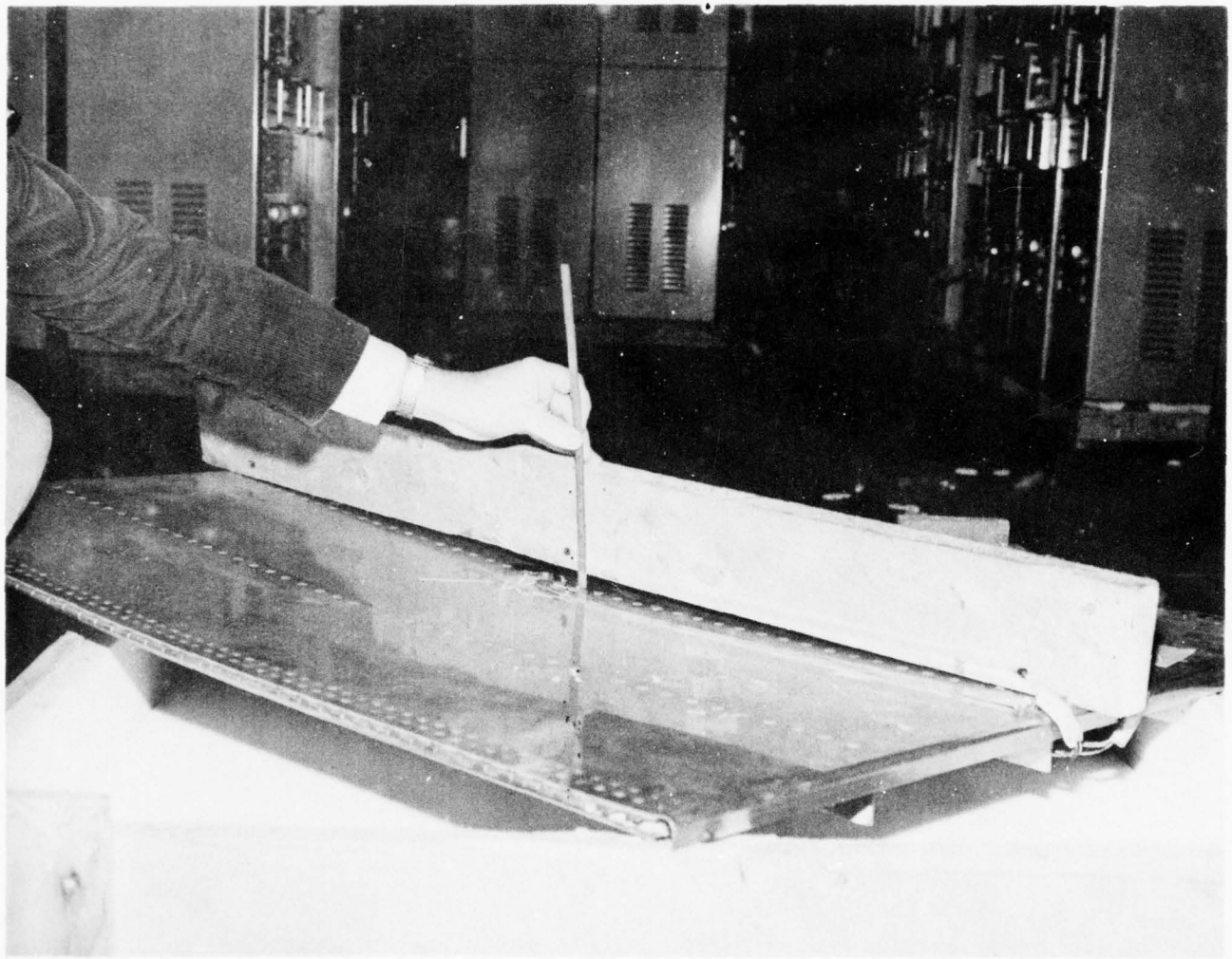


FIGURE 10-6 - SPECIMEN NO. 10 - INDICATION OF SHOCK TEST PERMANENT DEFORMATION

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO. 10 - DYNAMIC ANALYSIS - ITERATIVE TPD SOLUTION                GP  1
         1           0                                                          GP  2
5000.     0.001       0.02       0.0                                           GP  3
0.0       0.0         0.0        0.0                                           GP  4
        15          15                                                         GP  5
500.0                                                                          GP  7
                                                                               GP  8
         2           0                                                         GP  9
         0           1                                                         GP 10
0.5                                                                            GP 11
         0           0                                                         GP 12
         0           0                                                         GP 15
         2           2                                                         GP 18
48.0      0.0                                                                  GP 19
20.0     96.0                                                                  GP 19
-60.0     0.0                                                                  GP 20
-70.0    96.0                                                                  GP 20
         0                                                                     GP 21
         4           6          1                                              GP 25
-21.0     0.0        21.0                                                      GP 26
                                                                               GP 30
         2           3          3          1          1          1  GPB  1
        35           4          4                                    GPB  2
0.0       0.0                                                                  GPB  5
1.0       0.0                                                                  GPB  6
2.0       0.0                                                                  GPB  6
3.0       0.0                                                                  GPB  6
4.0       0.0                                                                  GPB  6
5.0       0.0                                                                  GPB  6
6.0       0.0                                                                  GPB  6
7.0       0.0                                                                  GPB  6
8.0       0.0                                                                  GPB  6
9.0       0.0                                                                  GPB  6
10.0      0.0                                                                  GPB  6
11.0      0.0                                                                  GPB  6
12.0      0.0                                                                  GPB  6
13.0      0.0                                                                  GPB  6
14.0      0.0                                                                  GPB  6
15.0      0.0                                                                  GPB  6
16.0      0.0                                                                  GPB  6
17.0      0.0                                                                  GPB  6
18.0      0.0                                                                  GPB  6
19.0      0.0                                                                  GPB  6
20.0      0.0                                                                  GPB  6
21.0      0.0                                                                  GPB  6
22.0      0.0                                                                  GPB  6
23.0      0.0                                                                  GPB  6
24.0      0.0                                                                  GPB  6
25.0      0.0                                                                  GPB  6
26.0      0.0                                                                  GPB  6
27.0      0.0                                                                  GPB  6
28.0      0.0                                                                  GPB  6
29.0      0.0                                                                  GPB  6
30.0      0.0                                                                  GPB  6
31.0      0.0                                                                  GPB  6
32.0      0.0                                                                  GPB  6
33.0      0.0                                                                  GPB  6
34.0      0.0                                                                  GPB  6
```

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NOVA-2 DATA DECK LISTING (CONTINUED)

```
35.0          0.0                                                          GPB  6
36.0          0.0                                                          GPB  7
              0                                                            GPB  8
              1             1             1             1                  GPB 12
.000259       .000259       .000259       .000259                        GPB 13
9.0                                                                        GPB 14
0.0625                                                                     GPB 15
1.74                                                                       GPB 16
              3                                                            GPB 17
.00404        39626.                                                       GPB 18
.0062         44000.                                                       GPB 18
.0092         49000.                                                       GPB 18
              3                                                            GPB 19
.00557        54620.                                                       GPB 20
.0094         56000.                                                       GPB 20
0.15          70200.                                                       GPB 20
0.098                                                                      GPB 15
1.005                                                                      GPB 16
              3                                                            GPB 17
.00368        39781.                                                       GPB 18
.0059         50000.                                                       GPB 18
.0084         54000.                                                       GPB 18
              3                                                            GPB 19
.00488        52710.                                                       GPB 20
.0088         58000.                                                       GPB 20
0.18          67310.                                                       GPB 20
2.0195                                                                     GPB 15
0.103                                                                      GPB 16
              3                                                            GPB 17
.00368        39781.                                                       GPB 18
.0059         50000.                                                       GPB 18
.0084         54000.                                                       GPB 18
              3                                                            GPB 19
.00488        52710.                                                       GPB 20
.0088         58000.                                                       GPB 20
0.18          67310.                                                       GPB 20
0.0645                                                                     GPB 15
0.724                                                                      GPB 16
              3                                                            GPB 17
.00368        39781.                                                       GPB 18
.0059         50000.                                                       GPB 18
.0084         54000.                                                       GPB 18
              3                                                            GPB 19
.00488        52710.                                                       GPB 20
.0088         58000.                                                       GPB 20
0.18          67310.                                                       GPB 20
.000001       0.005         25.0                                           GPB 22
                                                                           GP 32
```

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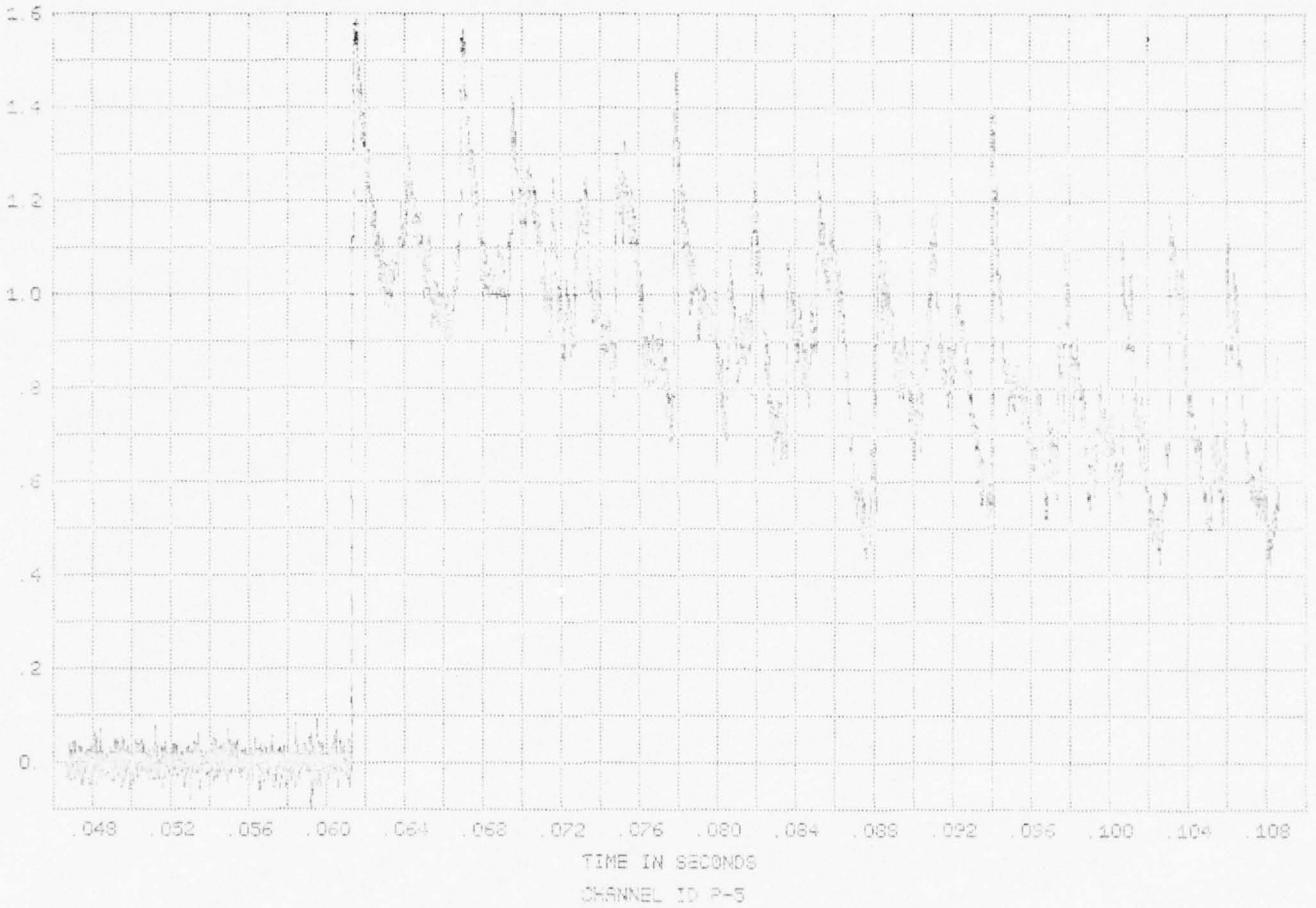


FIGURE 9-7 , SPECIMEN NO. 9 , SHOT NO. 1 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

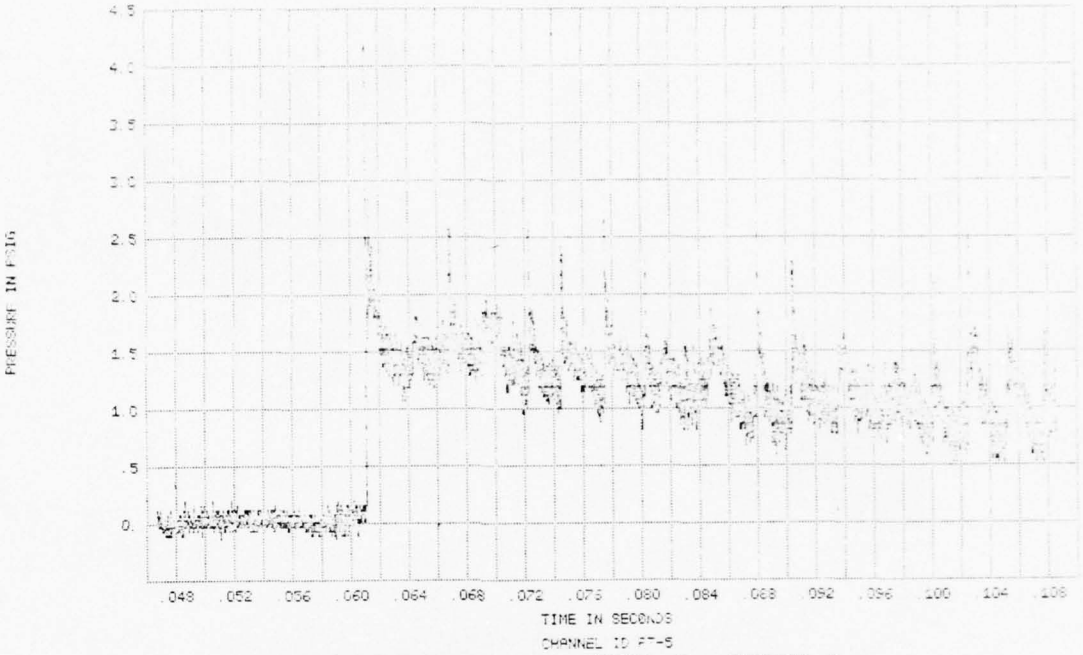


FIGURE 9-8 , SPECIMEN NO. 9 , SHOT NO. 1 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

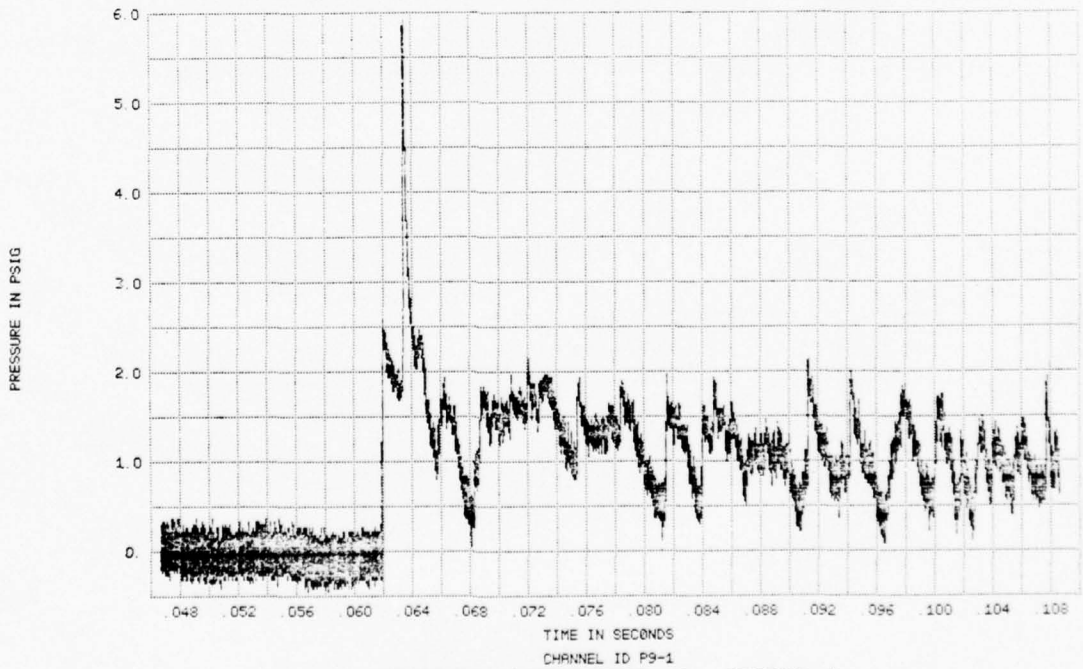


FIGURE 9-9 , SPECIMEN NO. 9 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

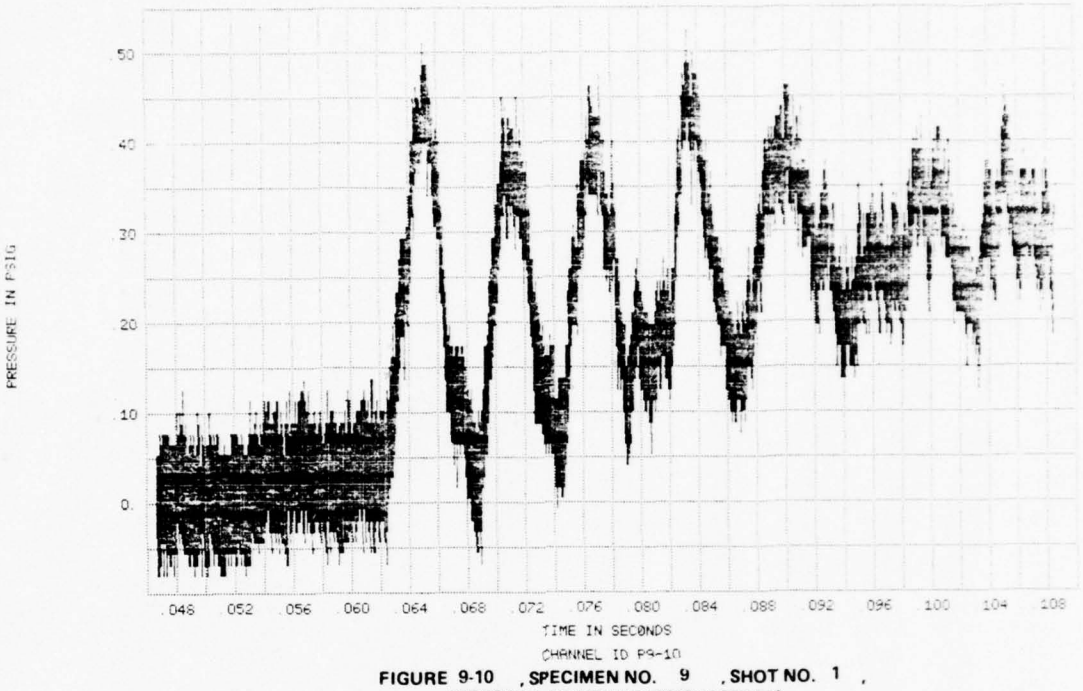


FIGURE 9-10 , SPECIMEN NO. 9 , SHOT NO. 1 ,
INTERNAL PRESSURE TIME HISTORY

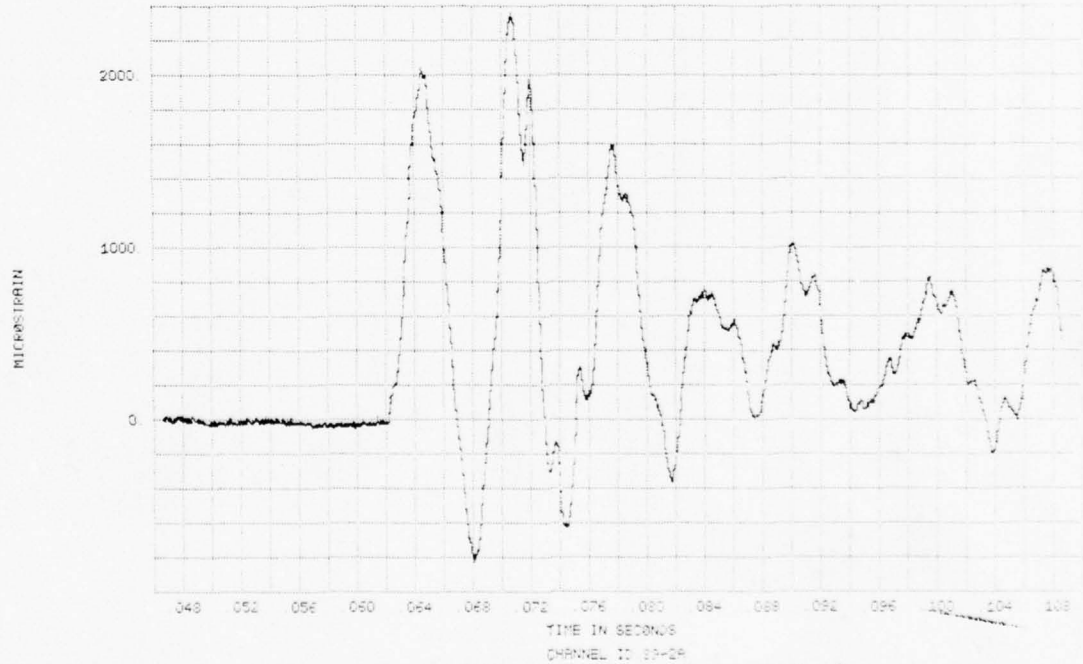


FIGURE 9-11 , SPECIMEN NO. 9 , SHOT NO. 1 ,
STRAIN TIME HISTORY

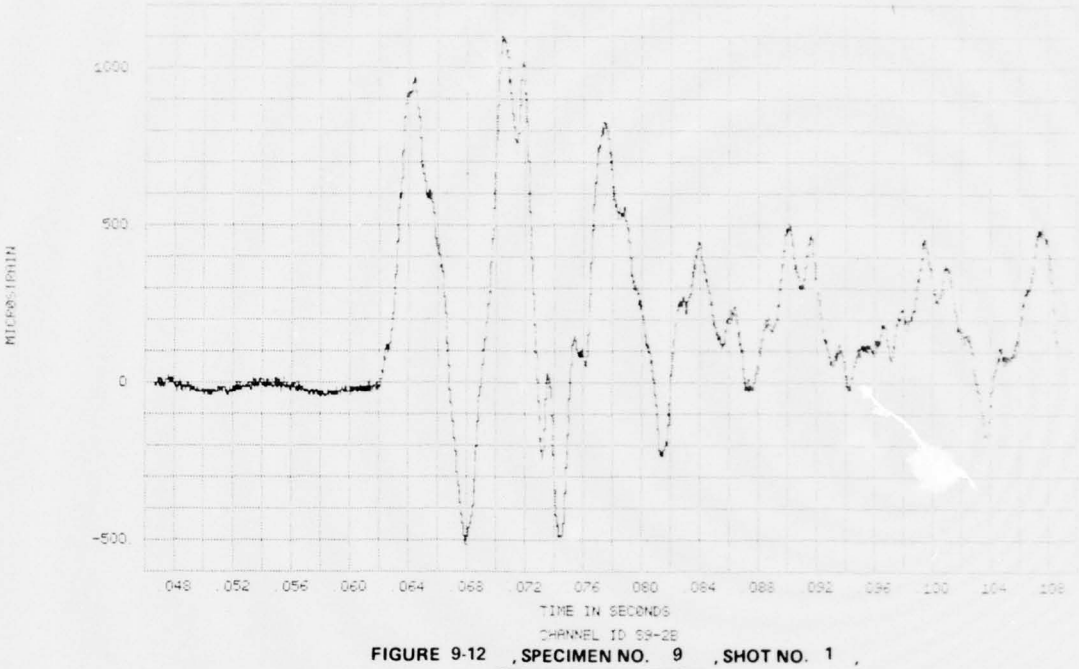


FIGURE 9-12 , SPECIMEN NO. 9 , SHOT NO. 1 ,
STRAIN TIME HISTORY

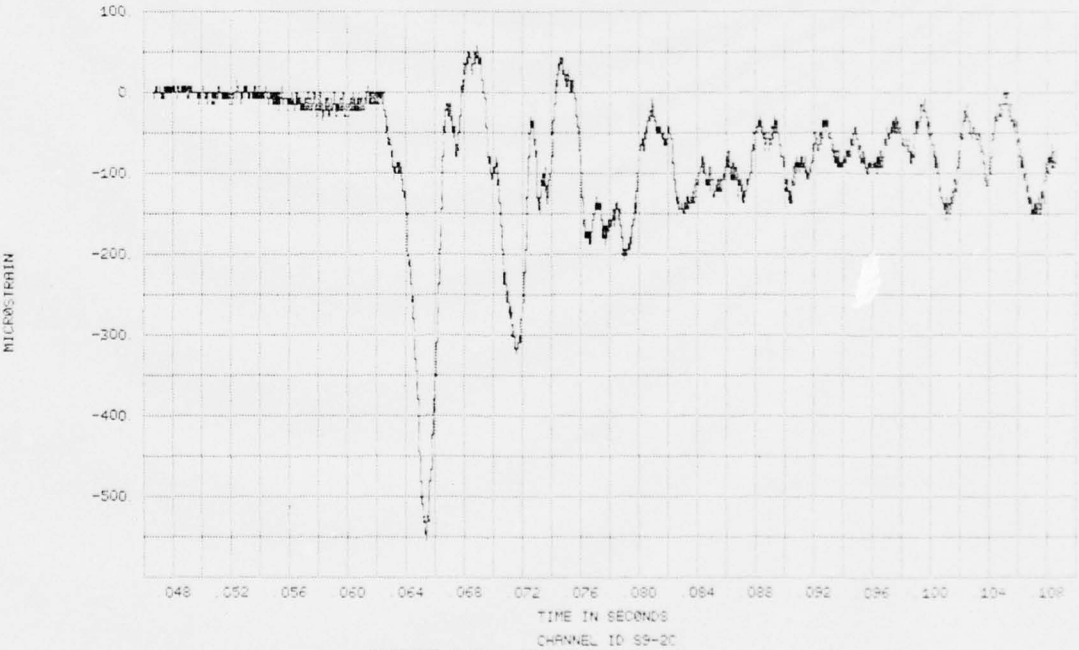


FIGURE 9-13 , SPECIMEN NO. 9 , SHOT NO. 1 ,
STRAIN TIME HISTORY

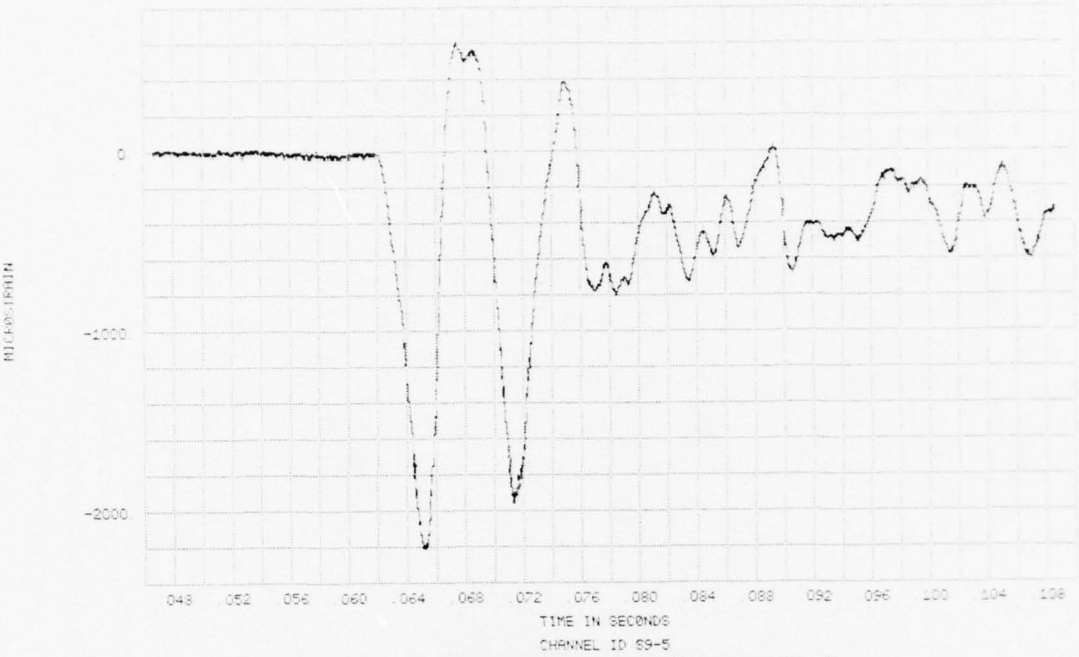


FIGURE 9-14 , SPECIMEN NO. 9 , SHOT NO. 1 ,
STRAIN TIME HISTORY

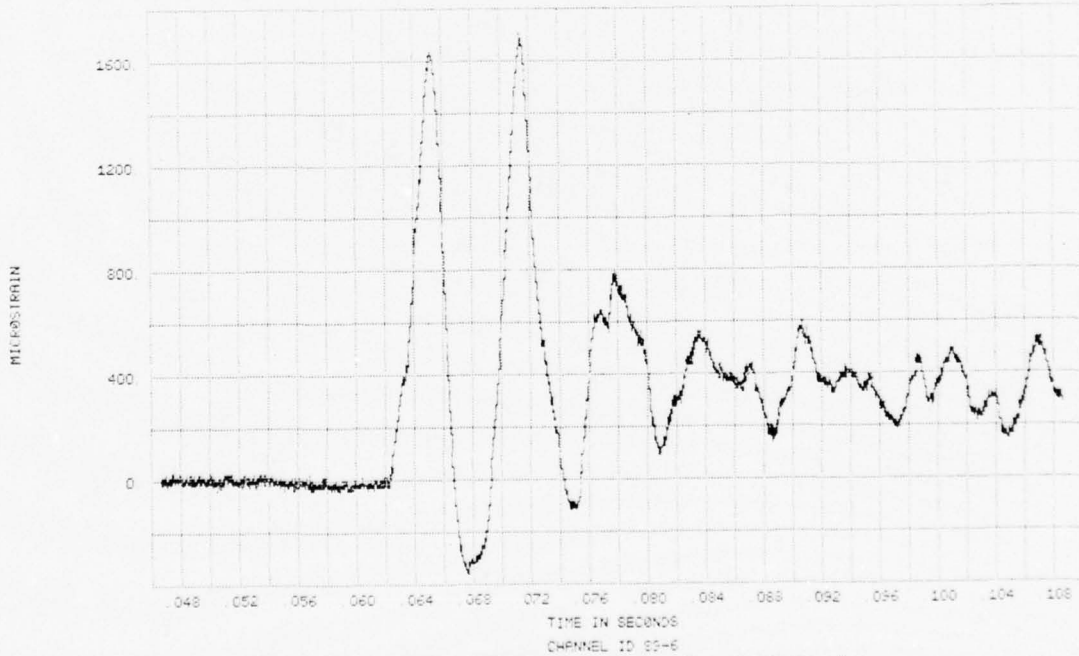


FIGURE 9-15 , SPECIMEN NO. 9 , SHOT NO. 1 ,
STRAIN TIME HISTORY

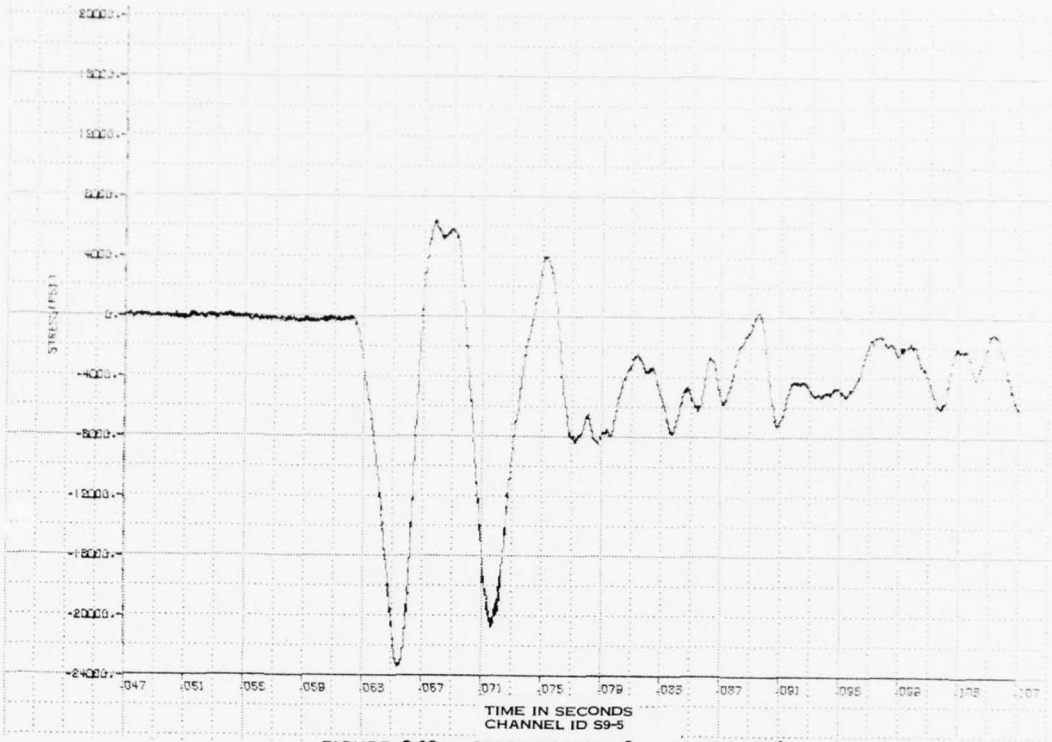


FIGURE 9-16 , SPECIMEN NO. 9 , SHOT NO. 1 ,
STRESS TIME HISTORY

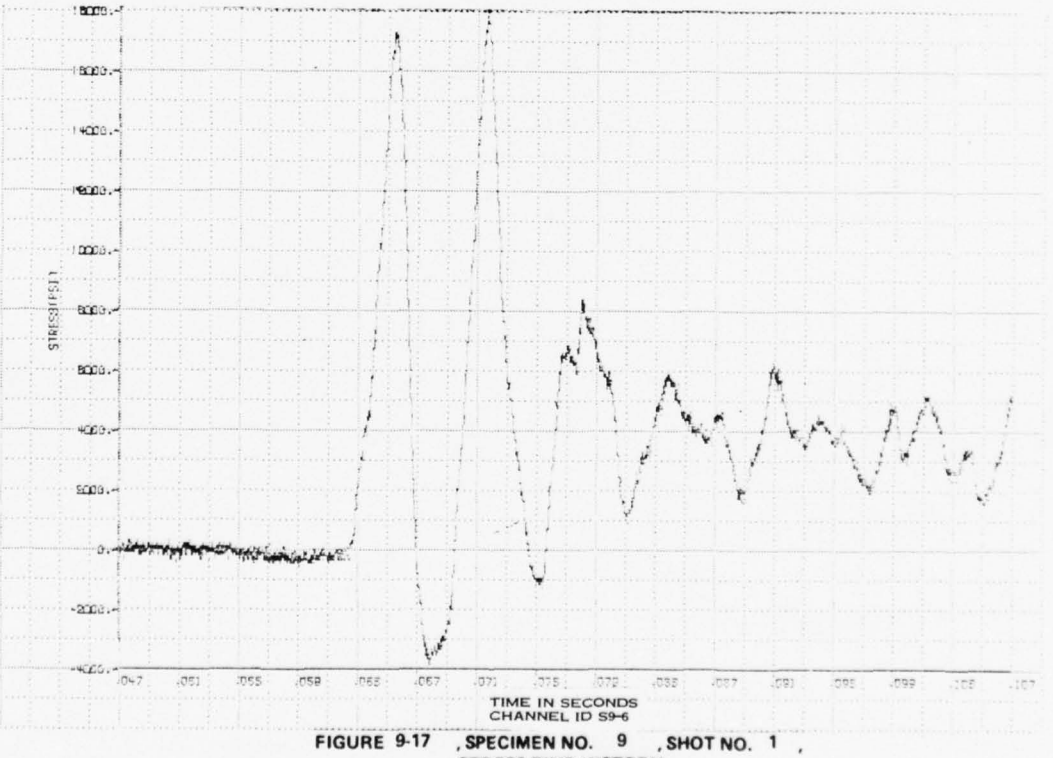


FIGURE 9-17 , SPECIMEN NO. 9 , SHOT NO. 1 ,
STRESS TIME HISTORY

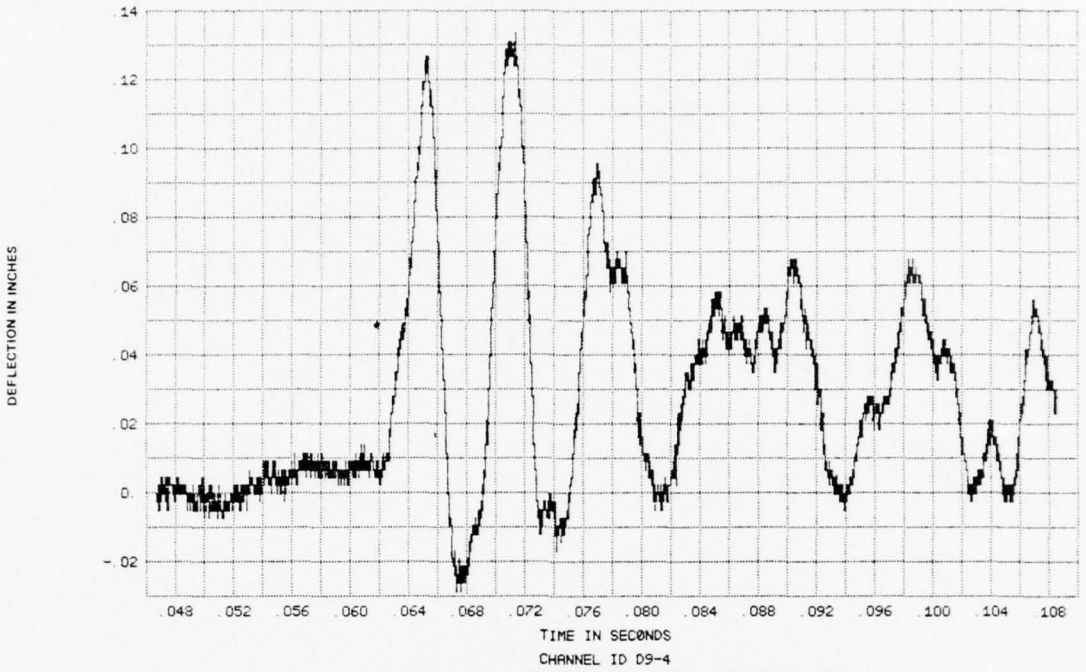


FIGURE 9-18 , SPECIMEN NO. 9 , SHOT NO. 1 ,
DEFLECTION TIME HISTORY

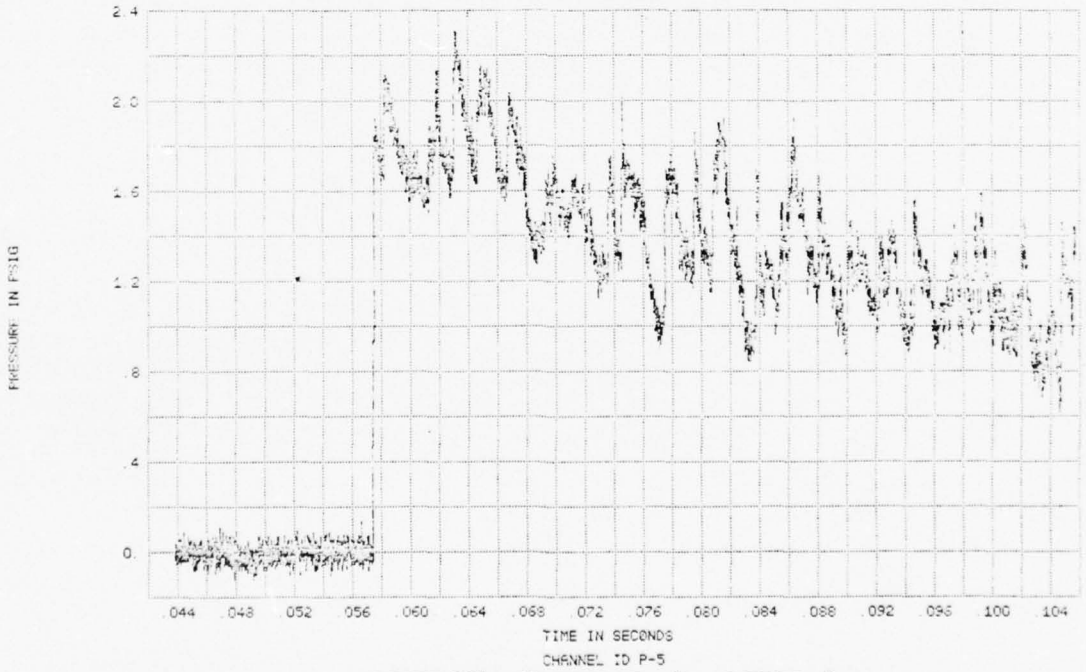


FIGURE 9-19 , SPECIMEN NO. 9 , SHOT NO. 2 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

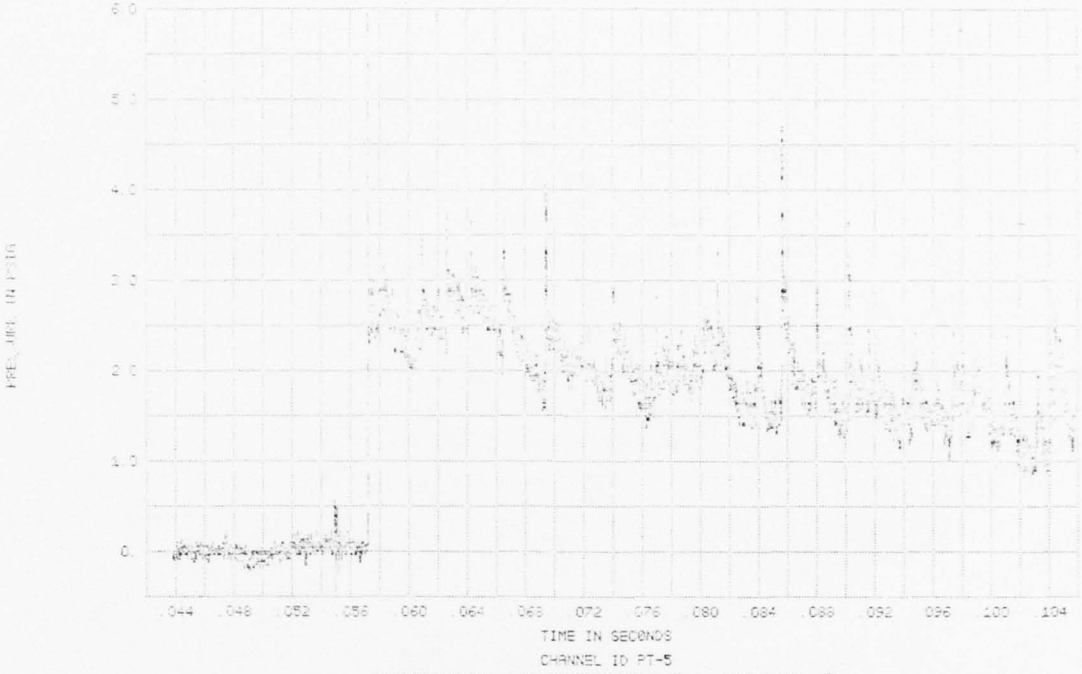


FIGURE 9-20 , SPECIMEN NO. 9 , SHOT NO. 2 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

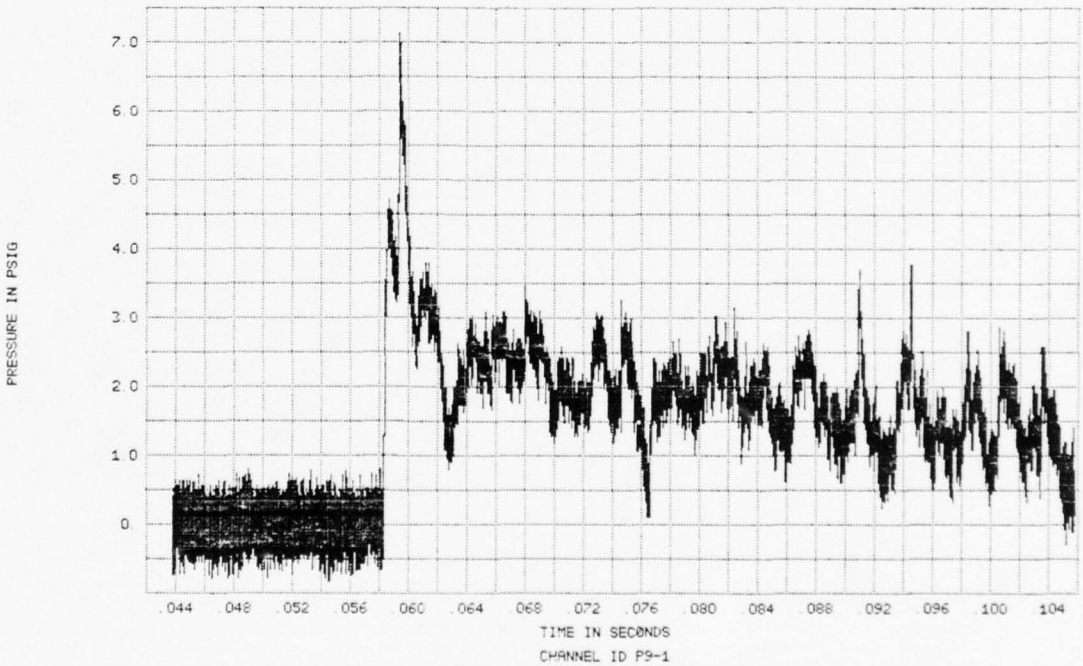


FIGURE 9-21 , SPECIMEN NO. 9 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

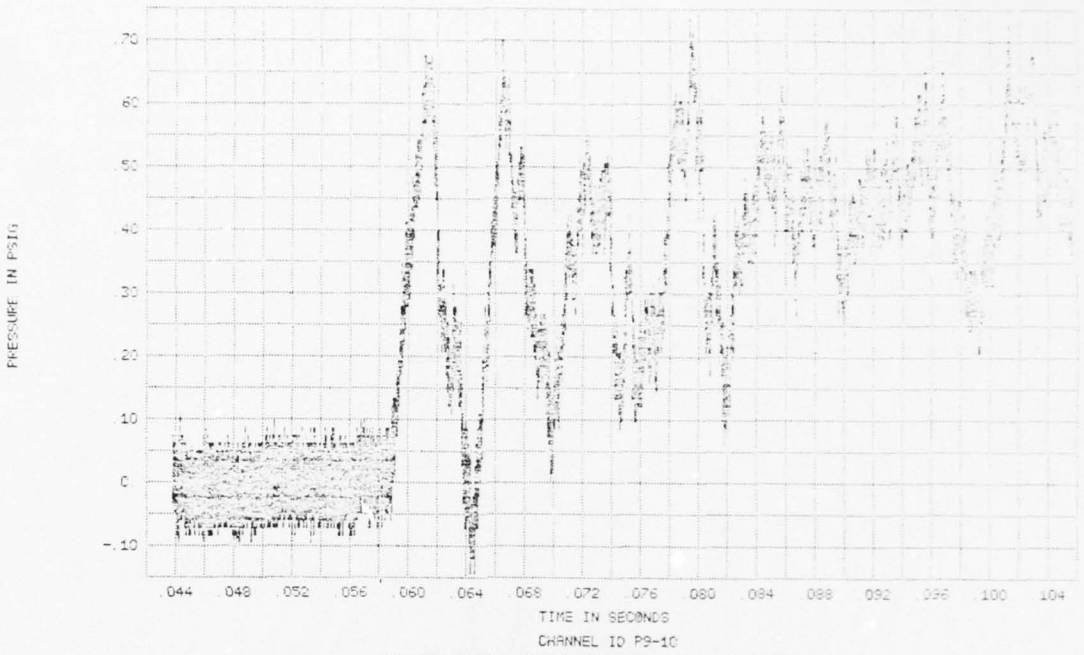


FIGURE 9-22 , SPECIMEN NO. 9 , SHOT NO. 2 ,
INTERNAL PRESSURE TIME HISTORY

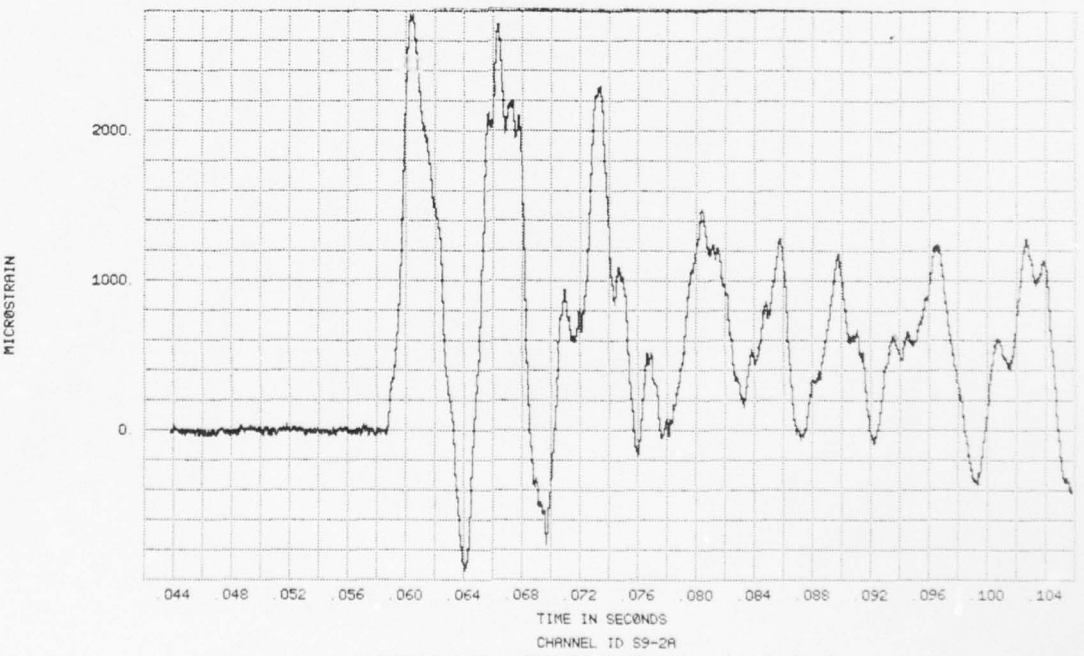


FIGURE 9-23 , SPECIMEN NO. 9 , SHOT NO. 2 ,
STRAIN TIME HISTORY

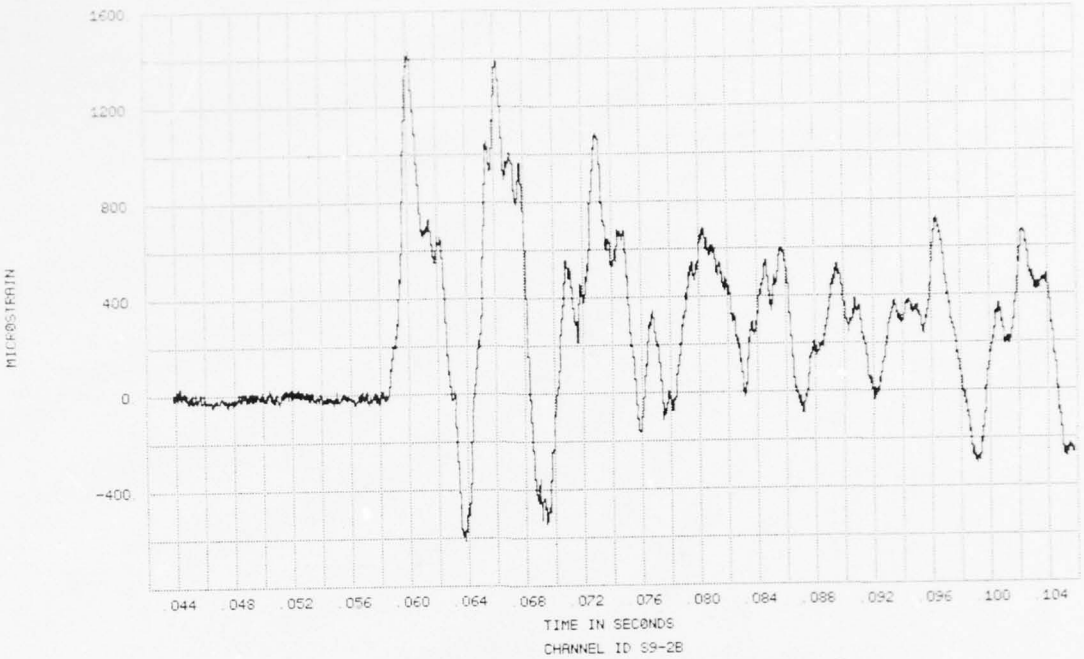


FIGURE 9-24 , SPECIMEN NO. 9 , SHOT NO. 2 ,
STRAIN TIME HISTORY

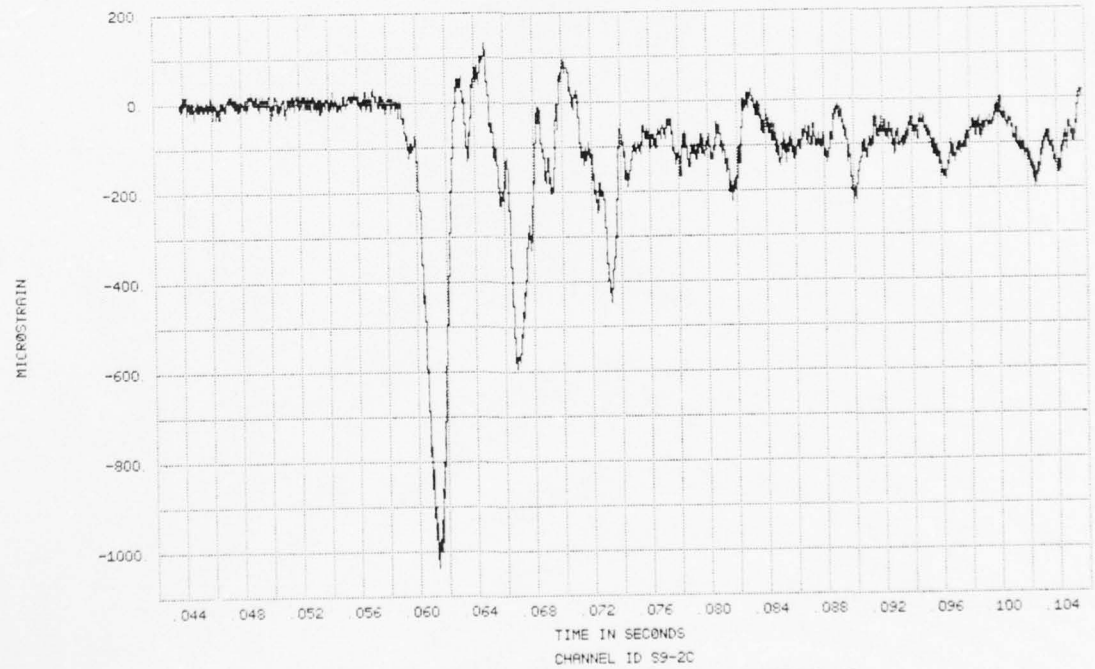


FIGURE 9-25 , SPECIMEN NO. 9 , SHOT NO. 2 ,
STRAIN TIME HISTORY

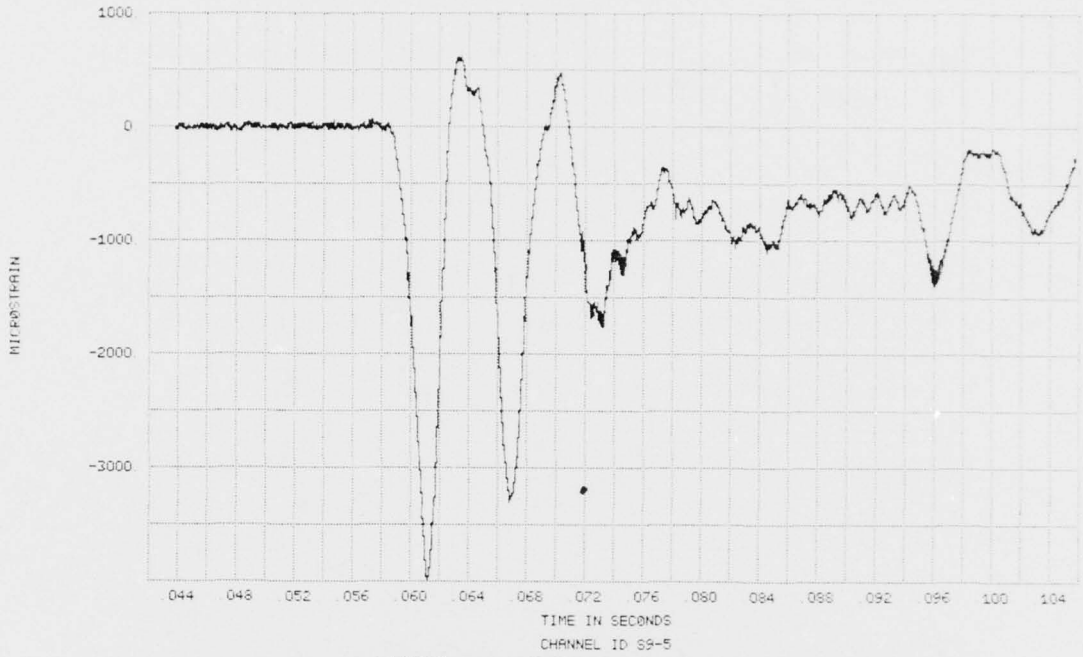


FIGURE 9-26 , SPECIMEN NO. 9 , SHOT NO. 2 ,
STRAIN TIME HISTORY

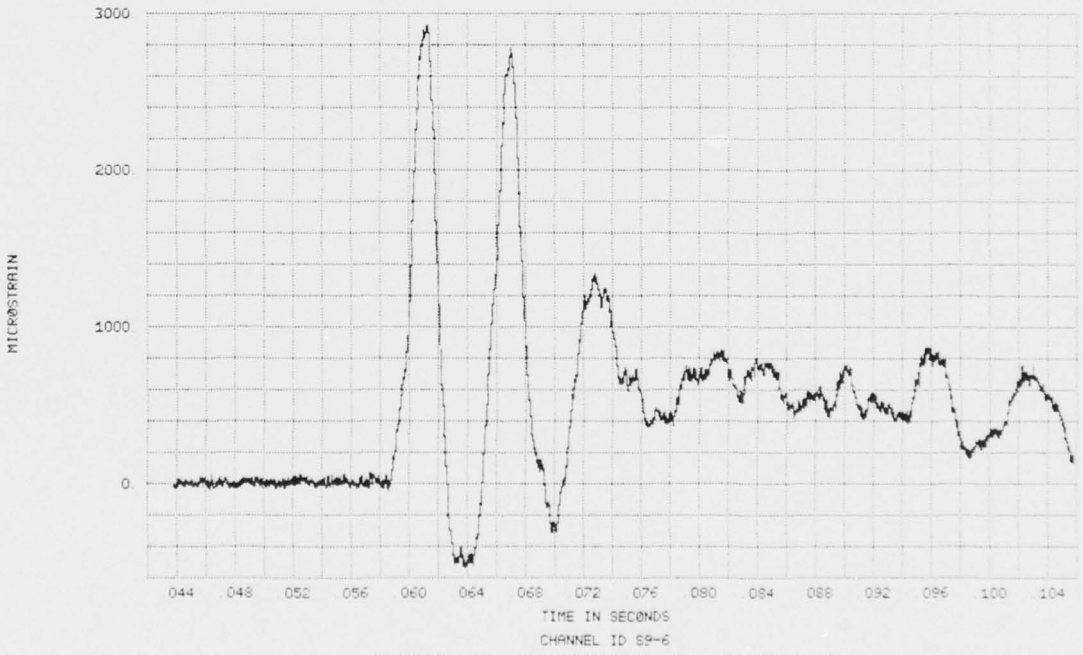


FIGURE 9-27 , SPECIMEN NO. 9 , SHOT NO. 2 ,
STRAIN TIME HISTORY

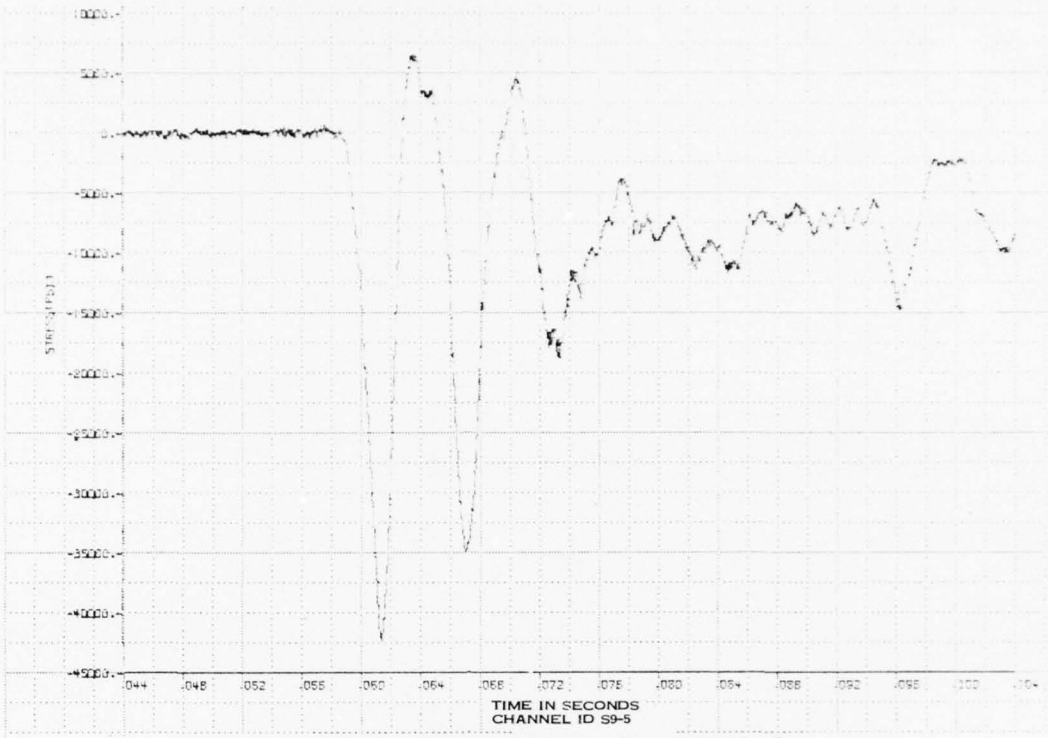


FIGURE 9-28 , SPECIMEN NO. 9 , SHOT NO. 2 ,
STRESS TIME HISTORY

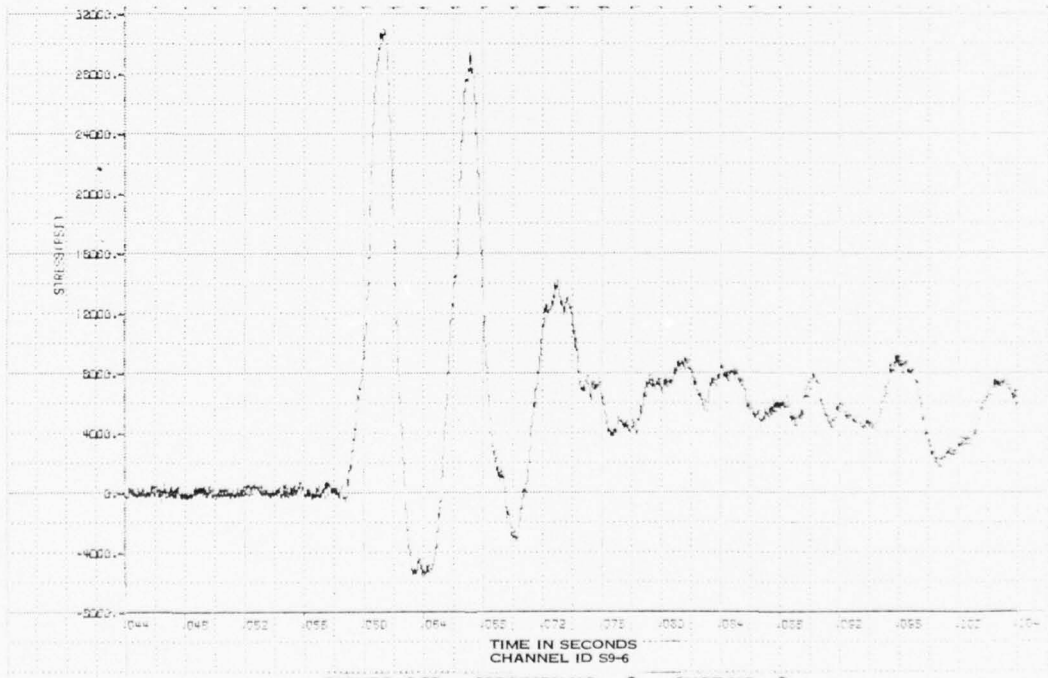


FIGURE 9-29 , SPECIMEN NO. 9 , SHOT NO. 2 ,
STRESS TIME HISTORY

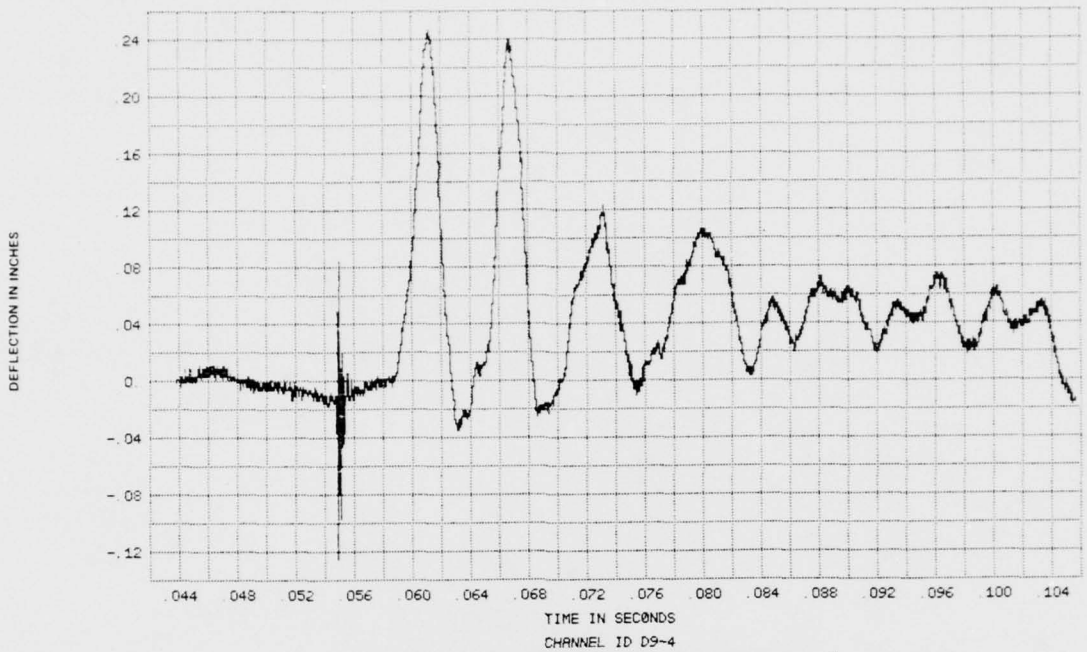


FIGURE 9-30 , SPECIMEN NO. 9 , SHOT NO. 2 ,
DEFLECTION TIME HISTORY

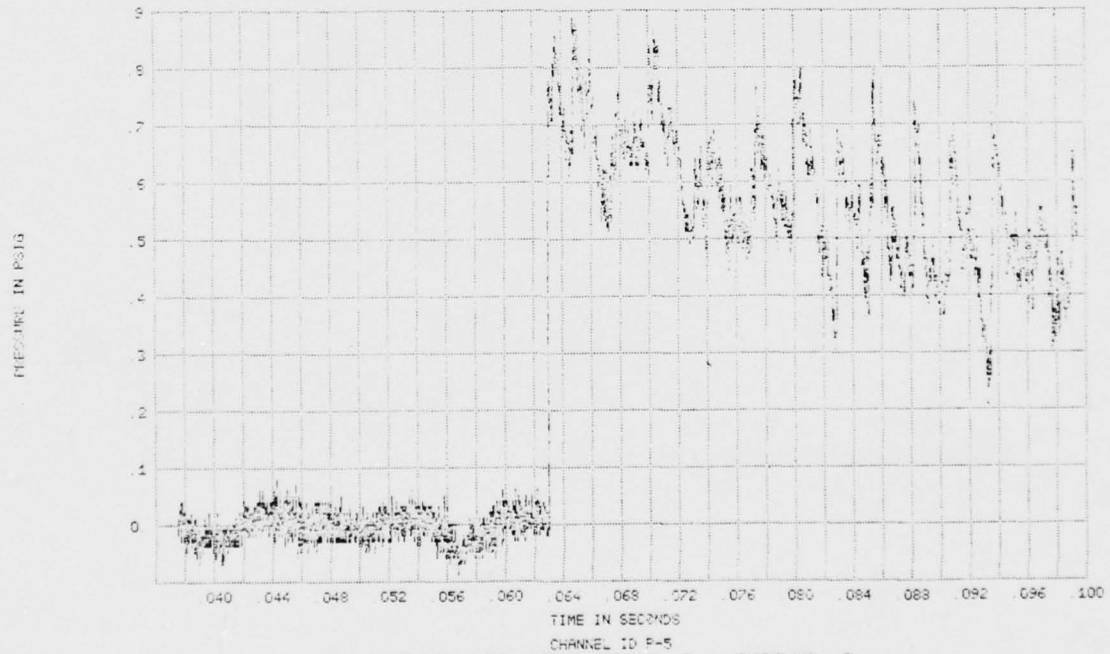


FIGURE 9-31 , SPECIMEN NO. 9 , SHOT NO. 3 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

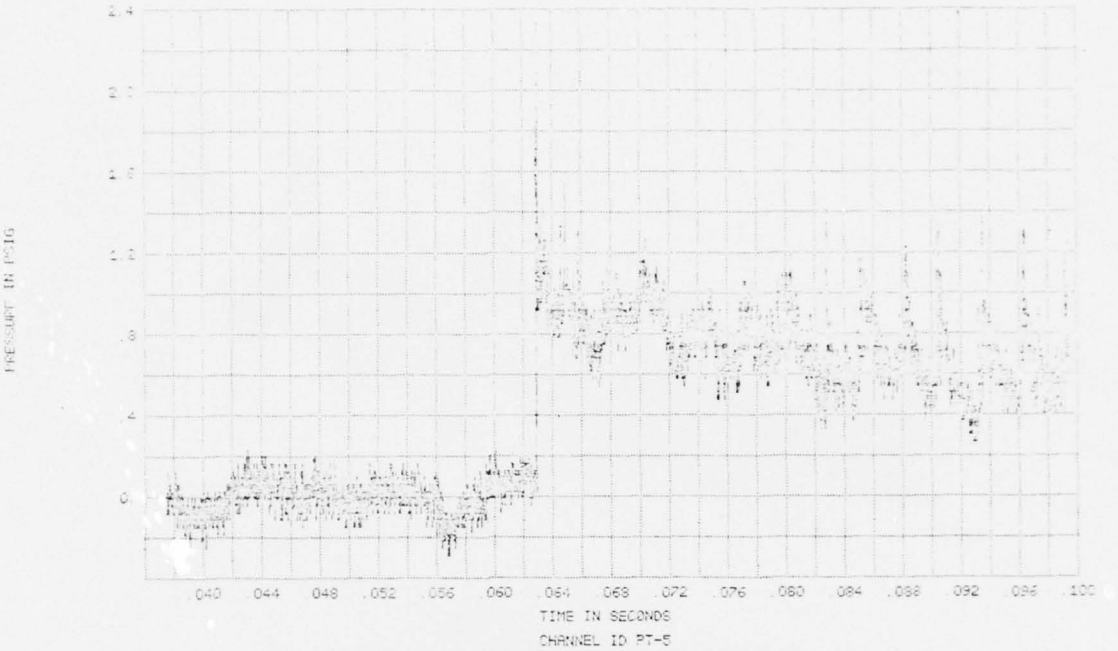


FIGURE 9-32 , SPECIMEN NO. 9 , SHOT NO. 3 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

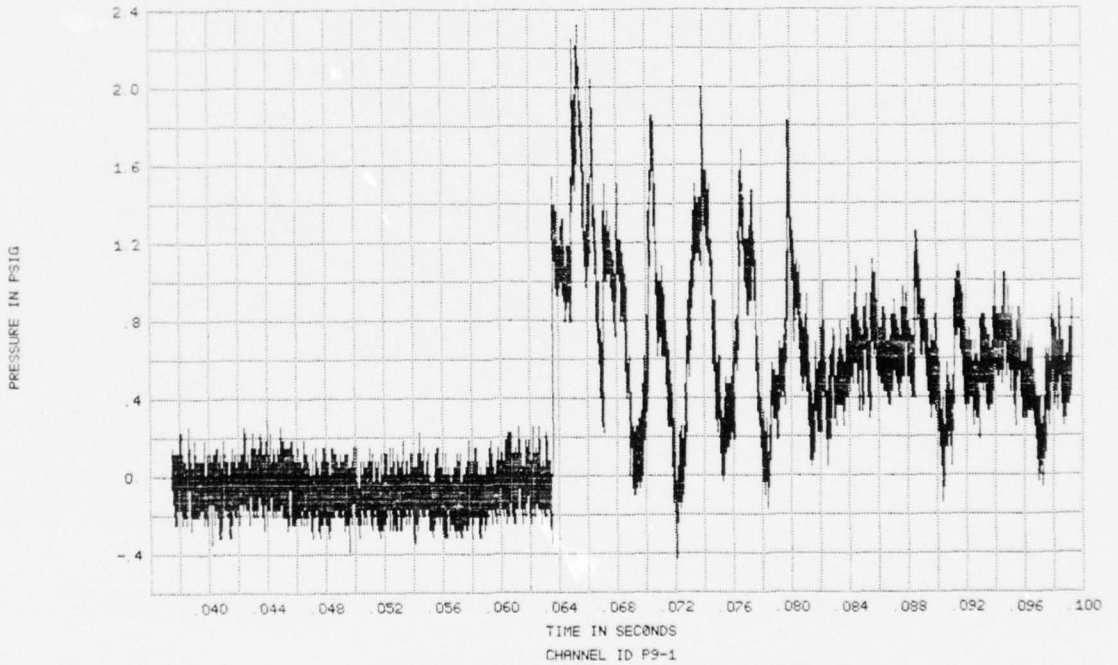


FIGURE 9-33 , SPECIMEN NO. 9 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

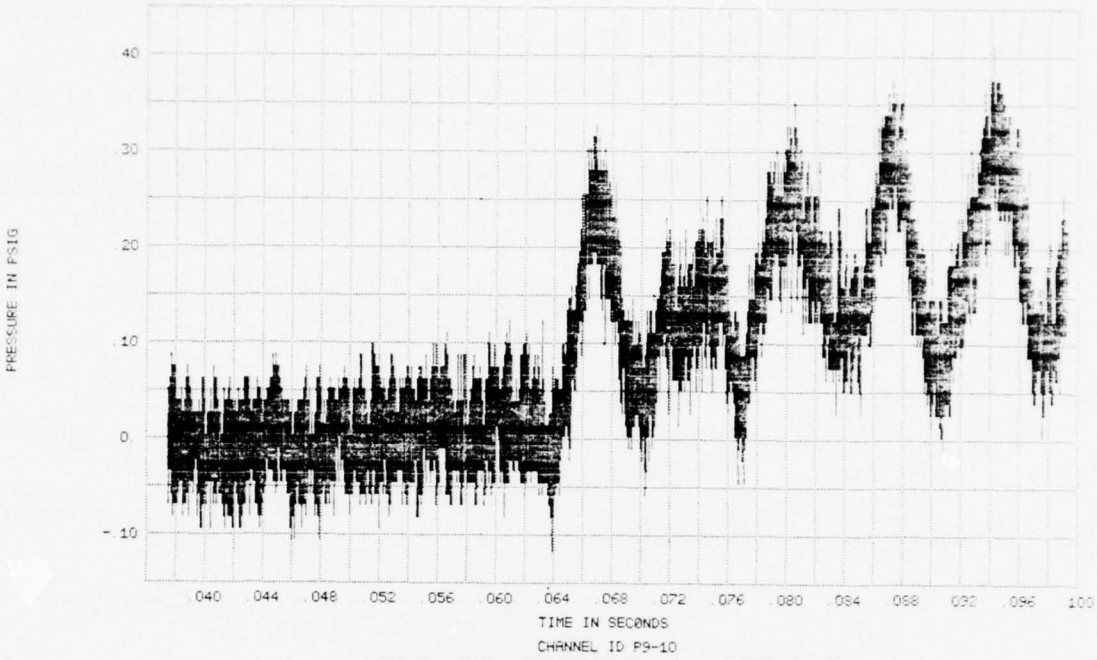


FIGURE 9-34 , SPECIMEN NO. 9 , SHOT NO. 3 ,
INTERNAL PRESSURE TIME HISTORY

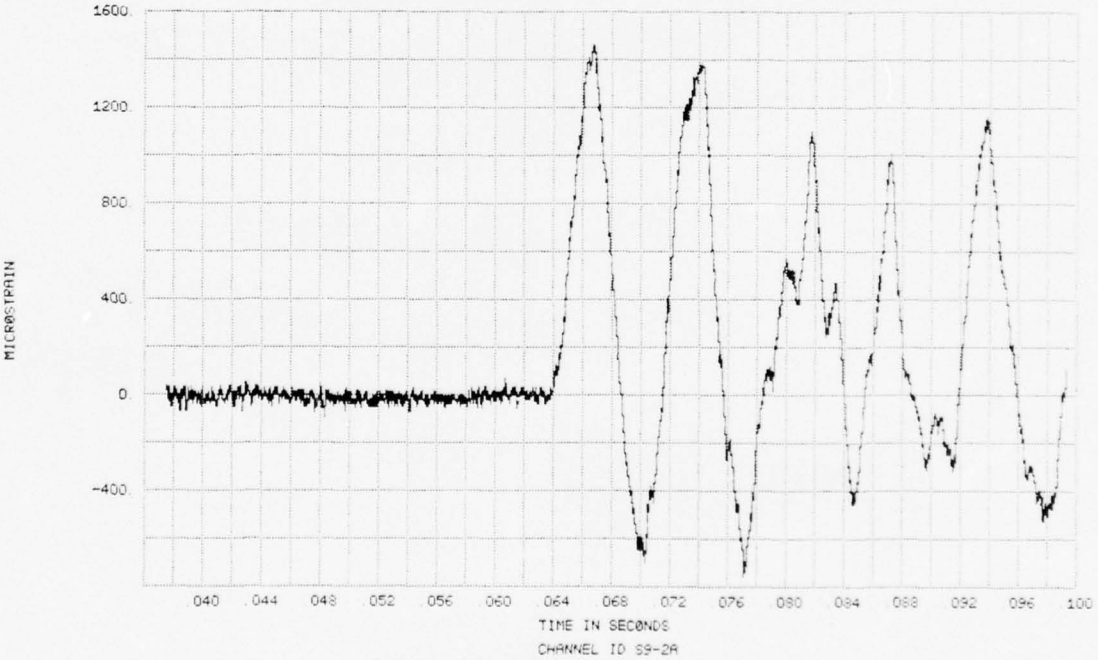


FIGURE 9-35 , SPECIMEN NO. 9 , SHOT NO. 3 ,
STRAIN TIME HISTORY

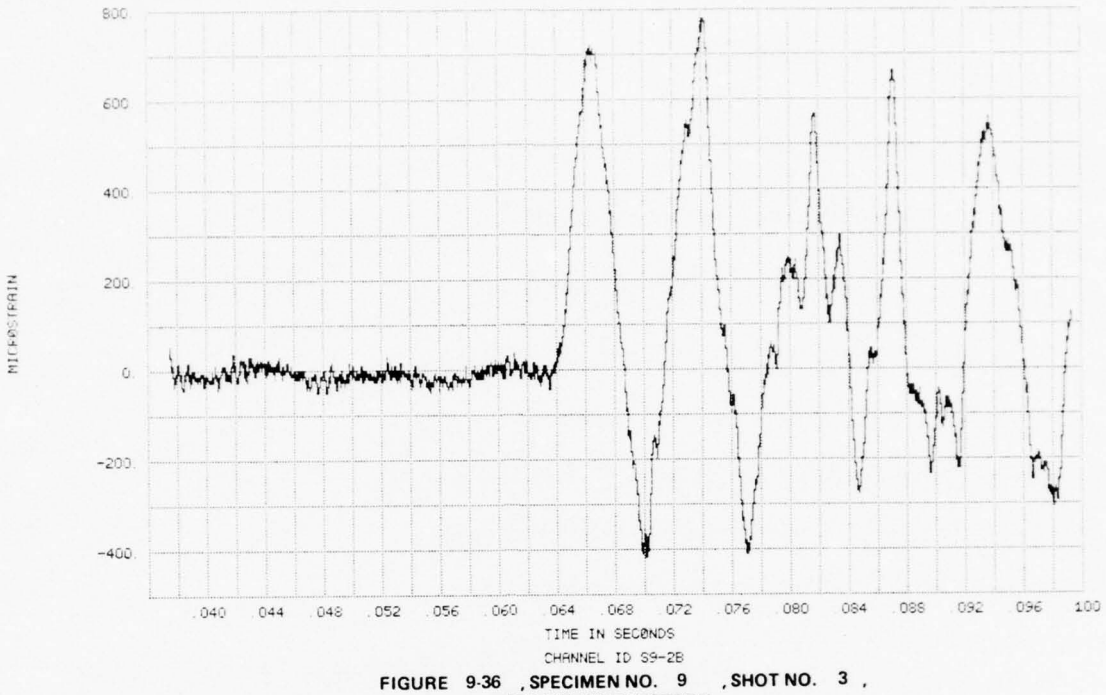


FIGURE 9-36 , SPECIMEN NO. 9 , SHOT NO. 3 , STRAIN TIME HISTORY

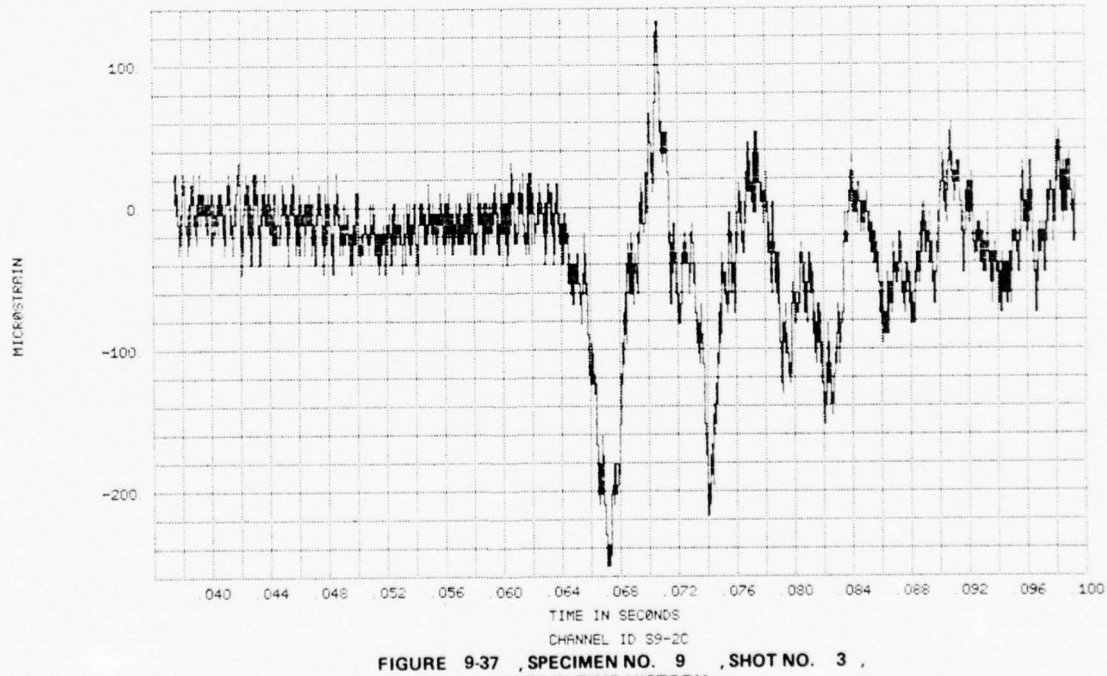


FIGURE 9-37 , SPECIMEN NO. 9 , SHOT NO. 3 , STRAIN TIME HISTORY

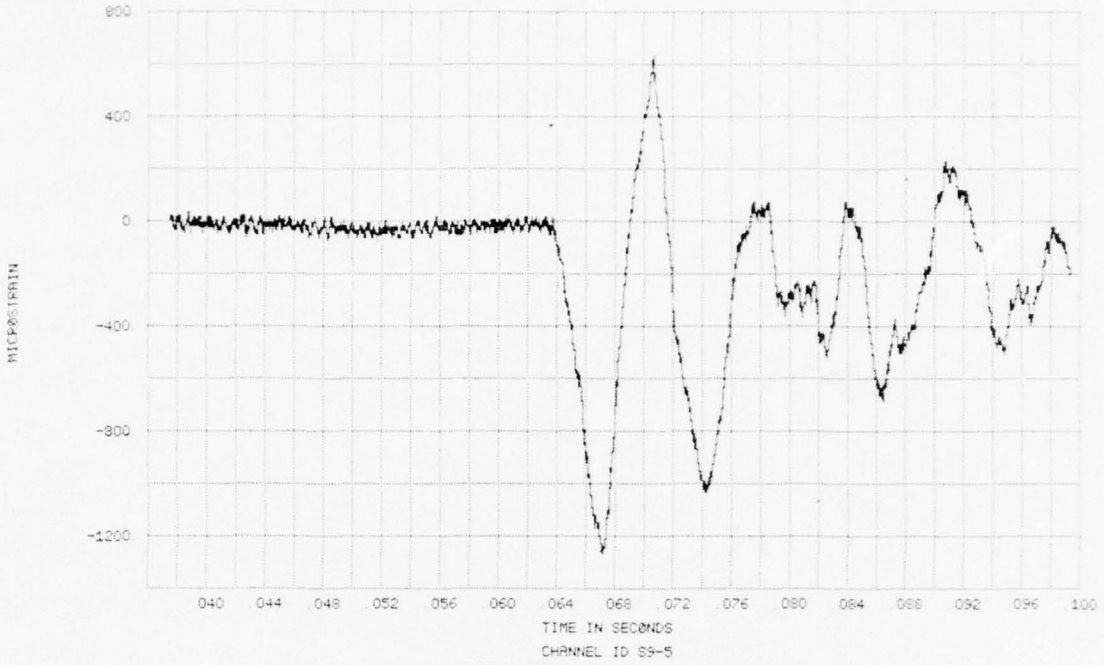


FIGURE 9-38 , SPECIMEN NO. 9 , SHOT NO. 3 ,
STRAIN TIME HISTORY

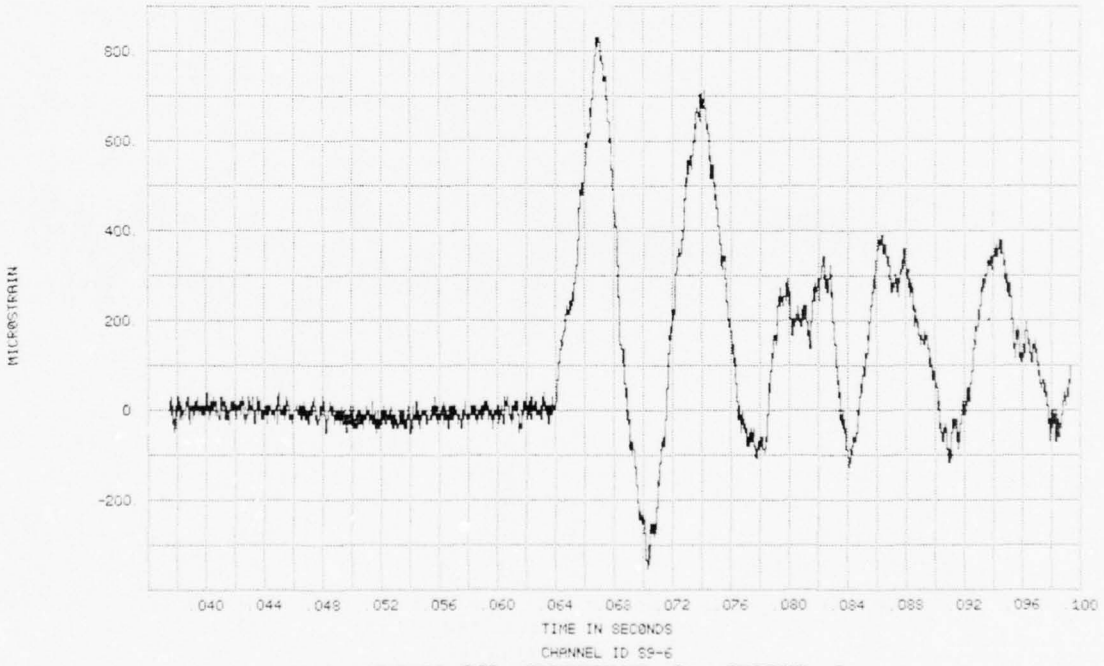


FIGURE 9-39 , SPECIMEN NO. 9 , SHOT NO. 3 ,
STRAIN TIME HISTORY

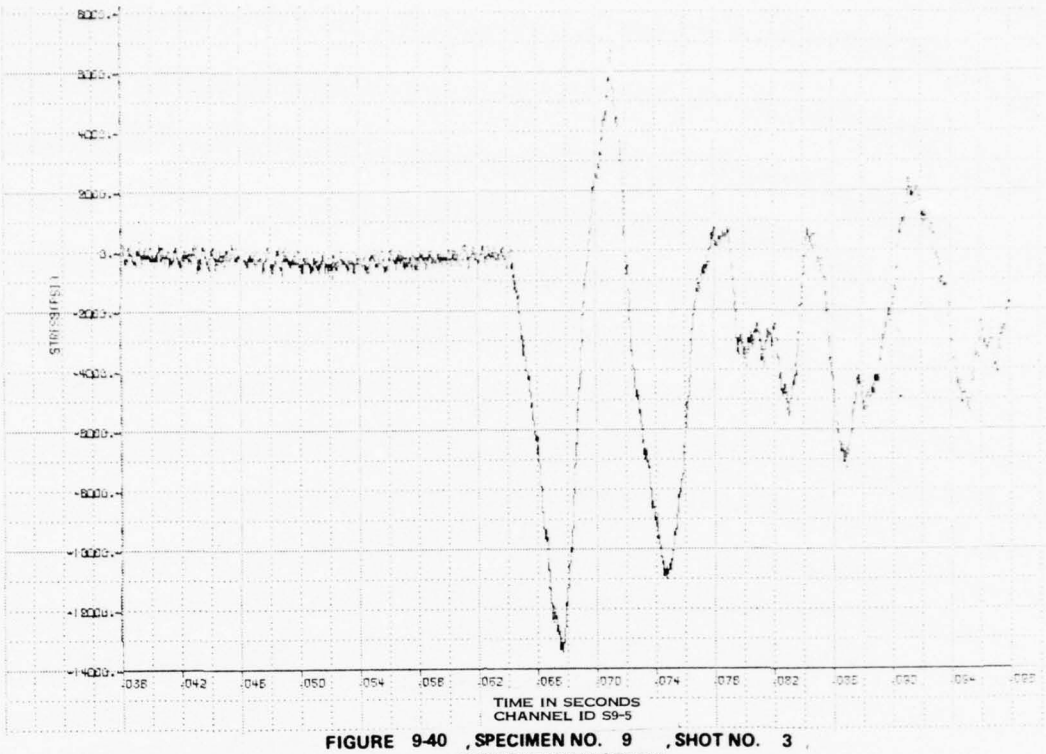


FIGURE 9-40 , SPECIMEN NO. 9 , SHOT NO. 3 ,
STRESS TIME HISTORY

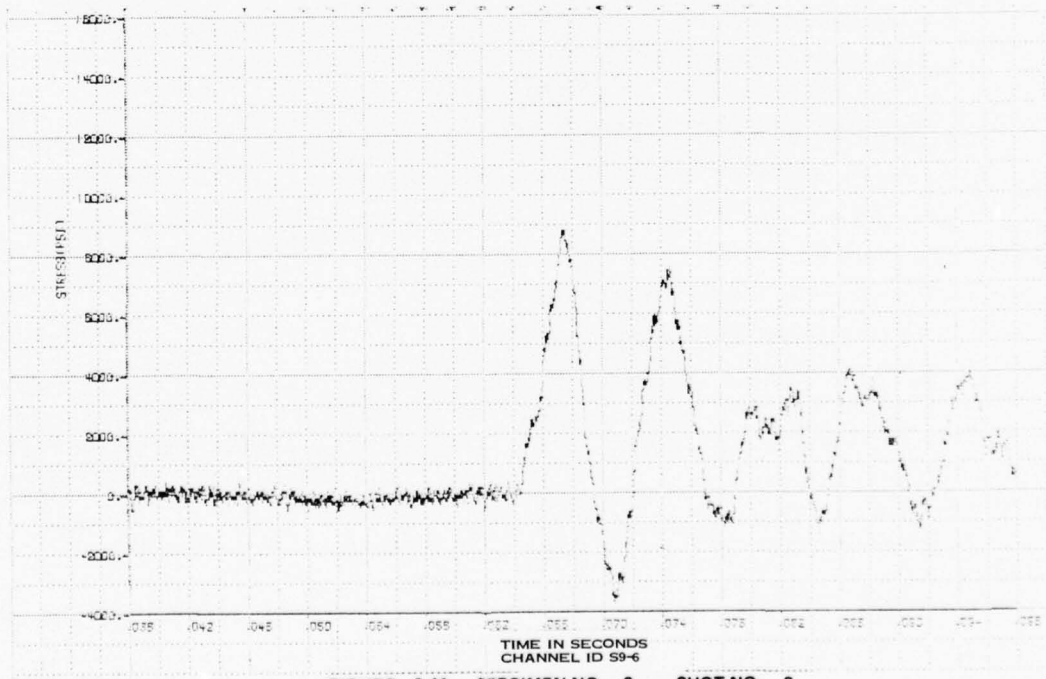


FIGURE 9-41 , SPECIMEN NO. 9 , SHOT NO. 3 ,
STRESS TIME HISTORY

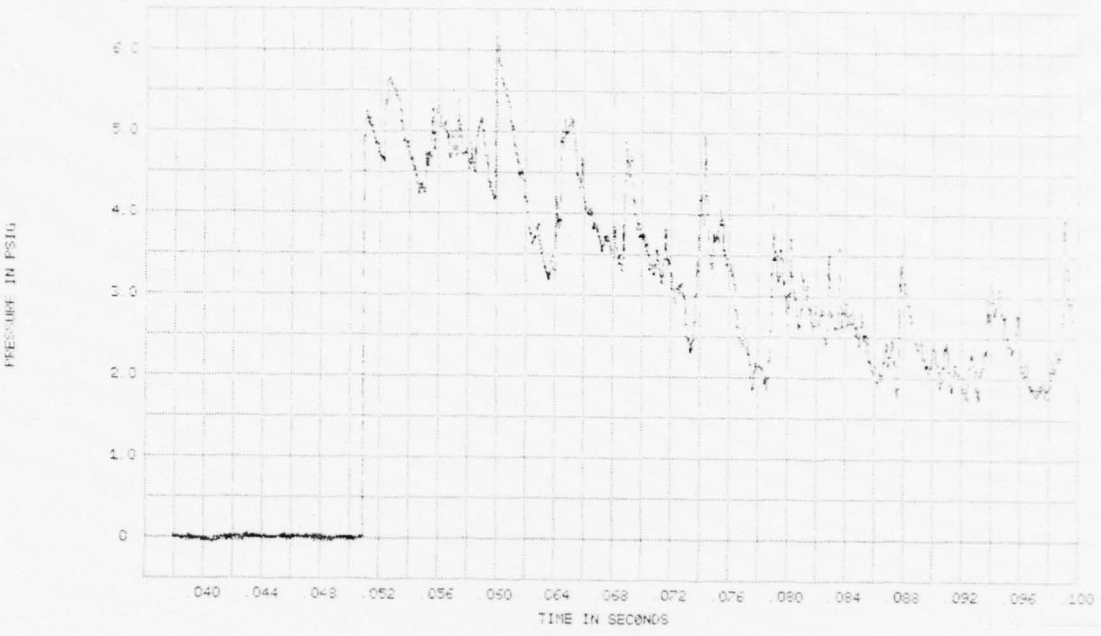


FIGURE 9-42 , SPECIMEN NO. 9 , SHOT NO. 4 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

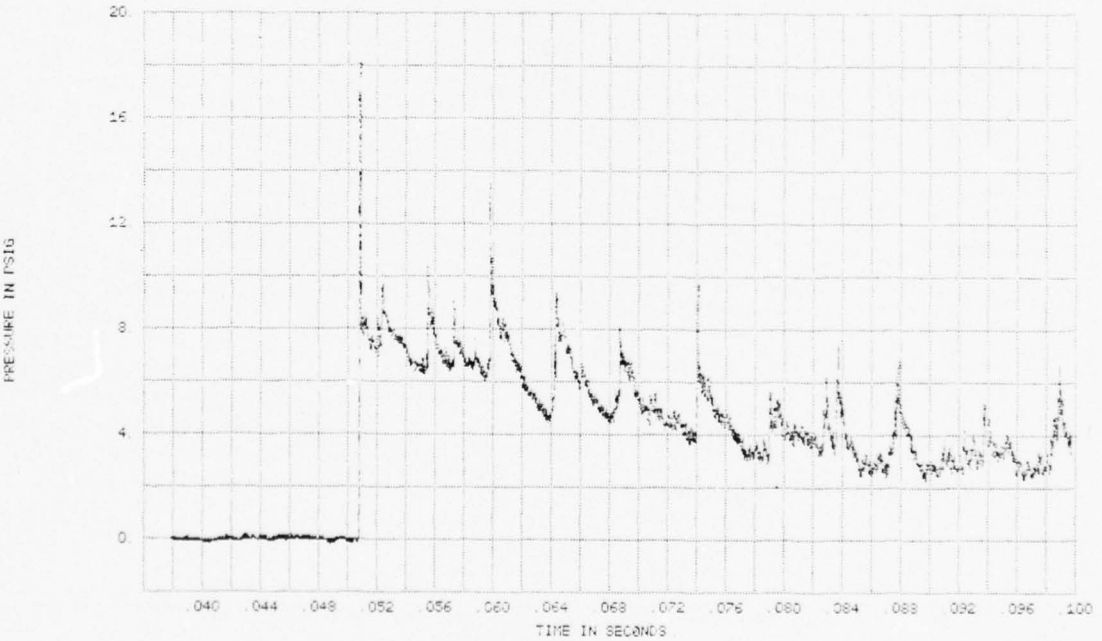


FIGURE 9-43 , SPECIMEN NO. 9 , SHOT NO. 4 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

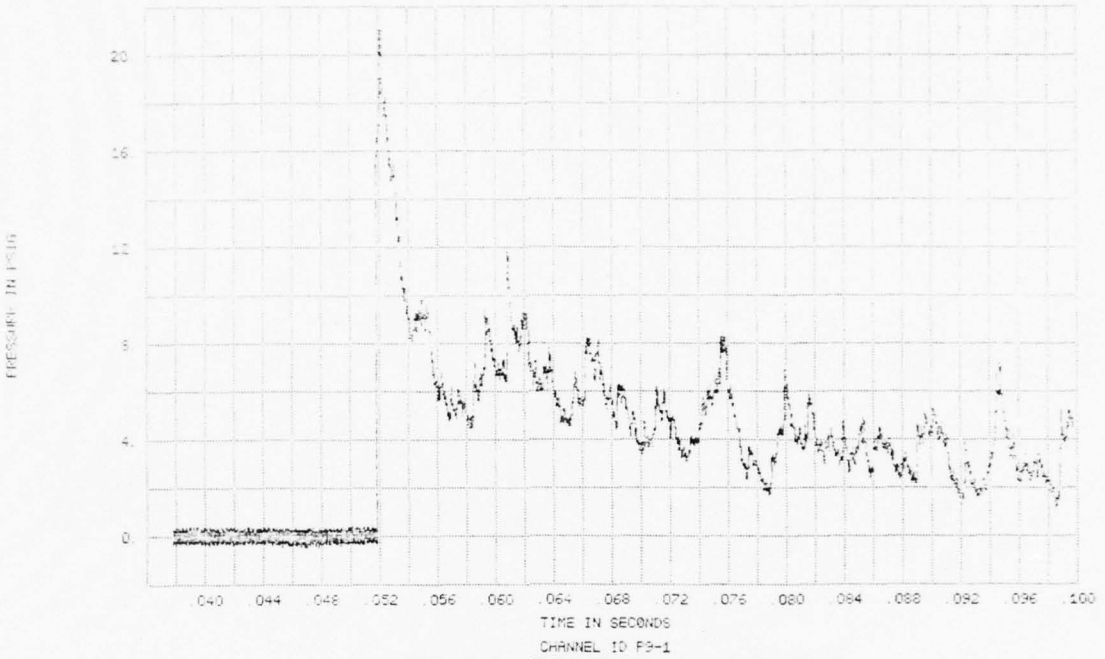


FIGURE 9-44 , SPECIMEN NO. 9 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

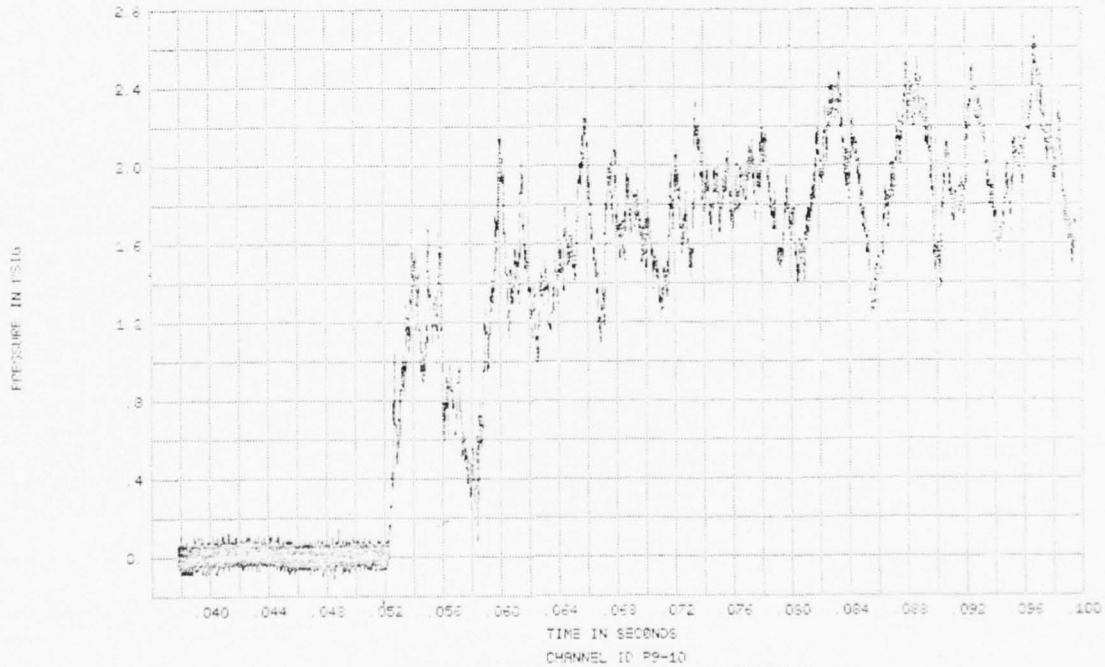


FIGURE 9-45 , SPECIMEN NO. 9 , SHOT NO. 4 ,
INTERNAL PRESSURE TIME HISTORY

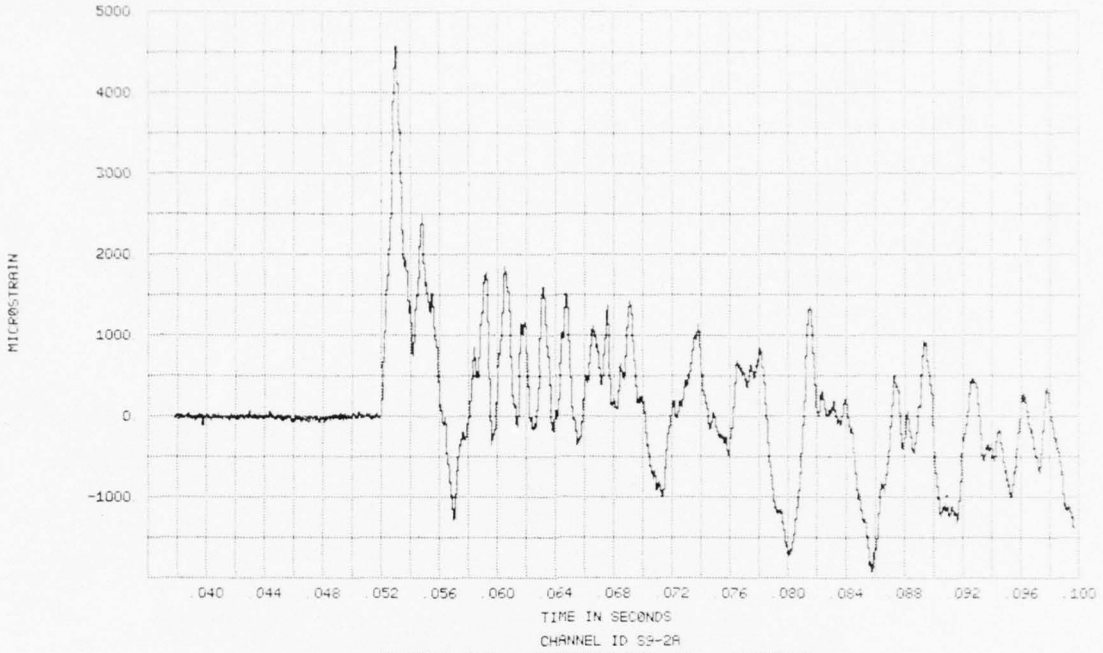


FIGURE 9-46 , SPECIMEN NO. 9 , SHOT NO. 4 , STRAIN TIME HISTORY

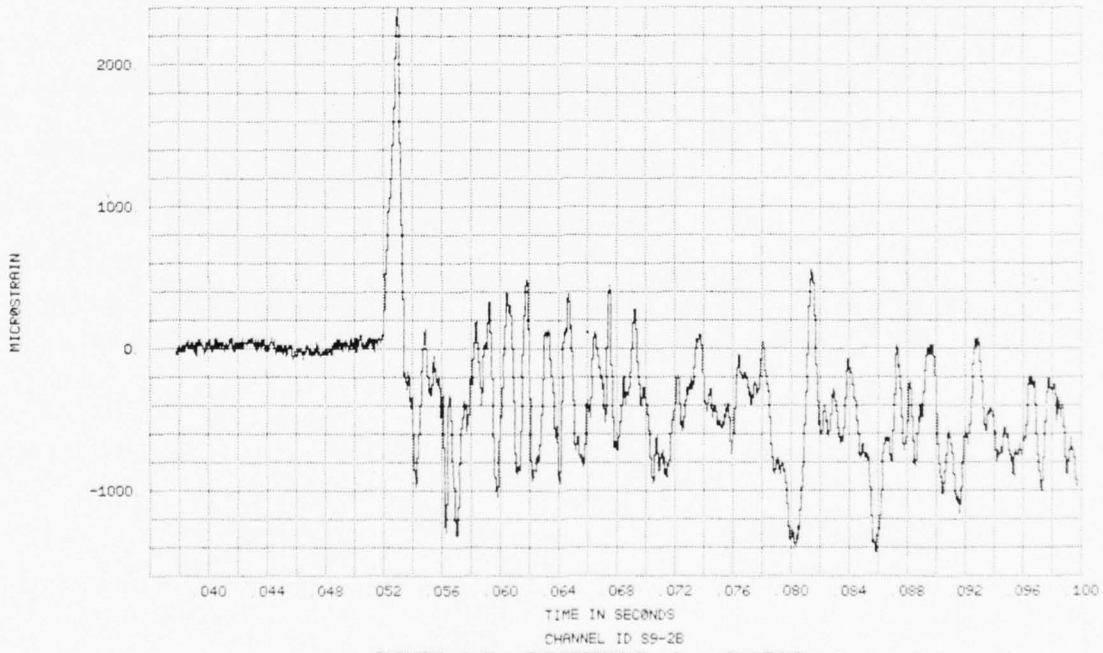


FIGURE 9-47 , SPECIMEN NO. 9 , SHOT NO. 4 , STRAIN TIME HISTORY

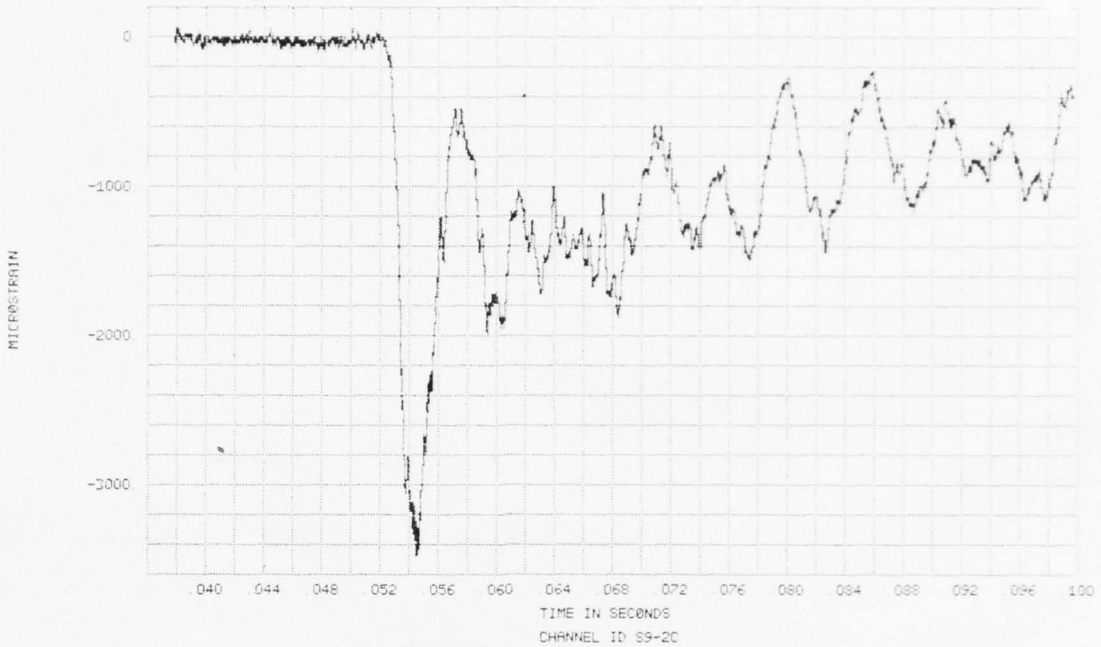


FIGURE 9-48 , SPECIMEN NO. 9 , SHOT NO. 4 ,
STRAIN TIME HISTORY

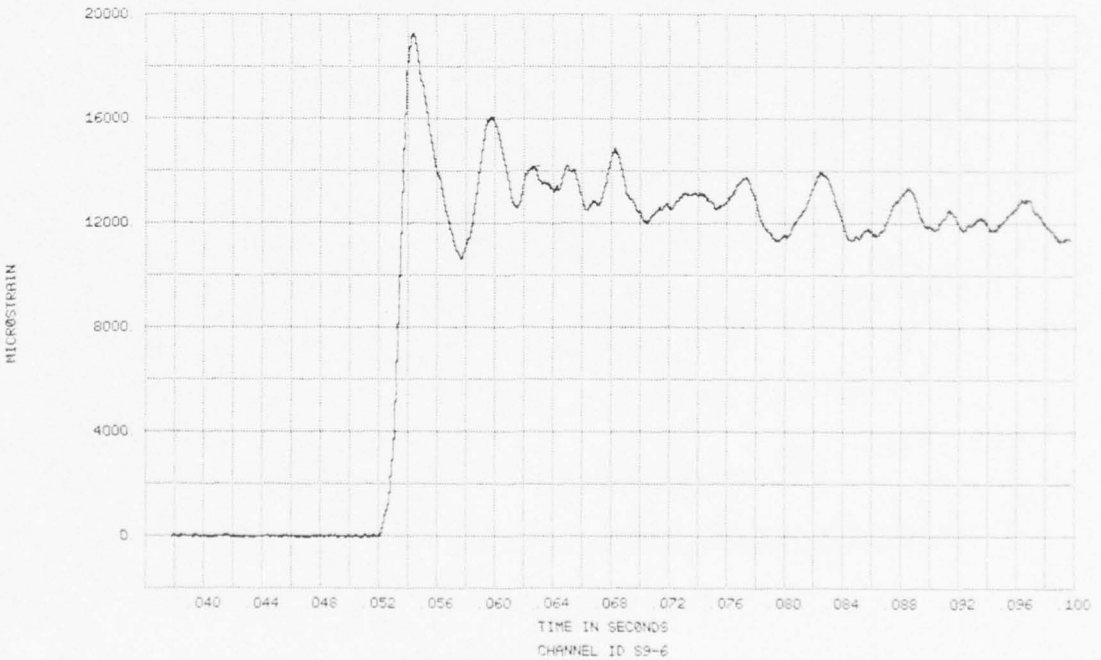


FIGURE 9-49 , SPECIMEN NO. 9 , SHOT NO. 4 ,
STRAIN TIME HISTORY

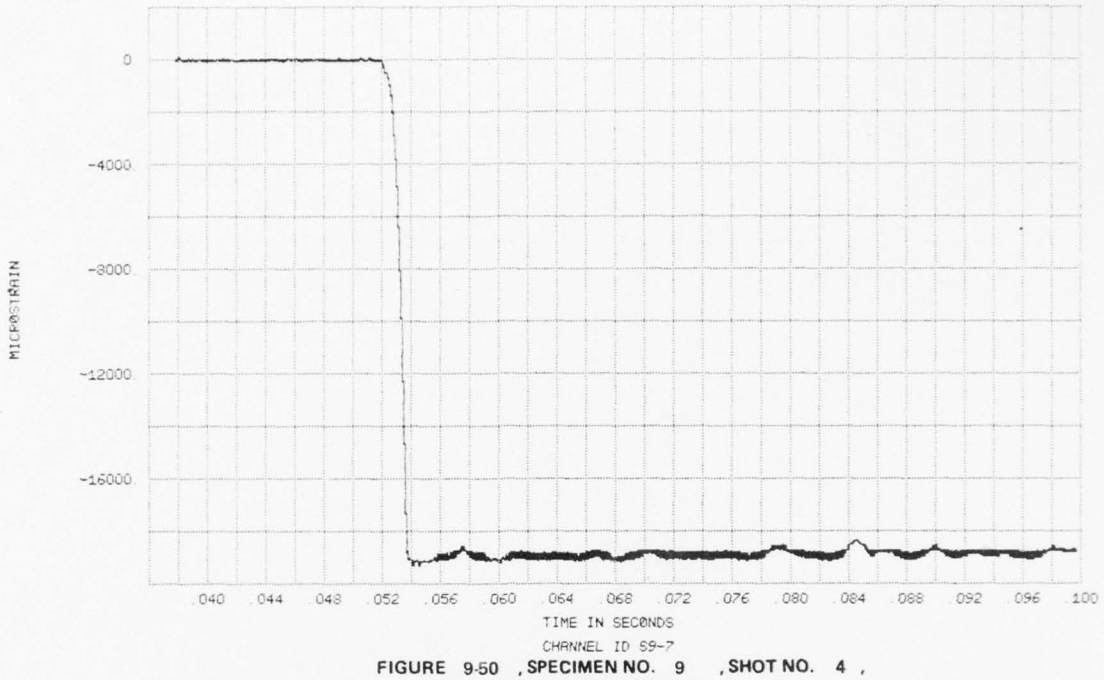


FIGURE 9-50 , SPECIMEN NO. 9 , SHOT NO. 4 , STRAIN TIME HISTORY

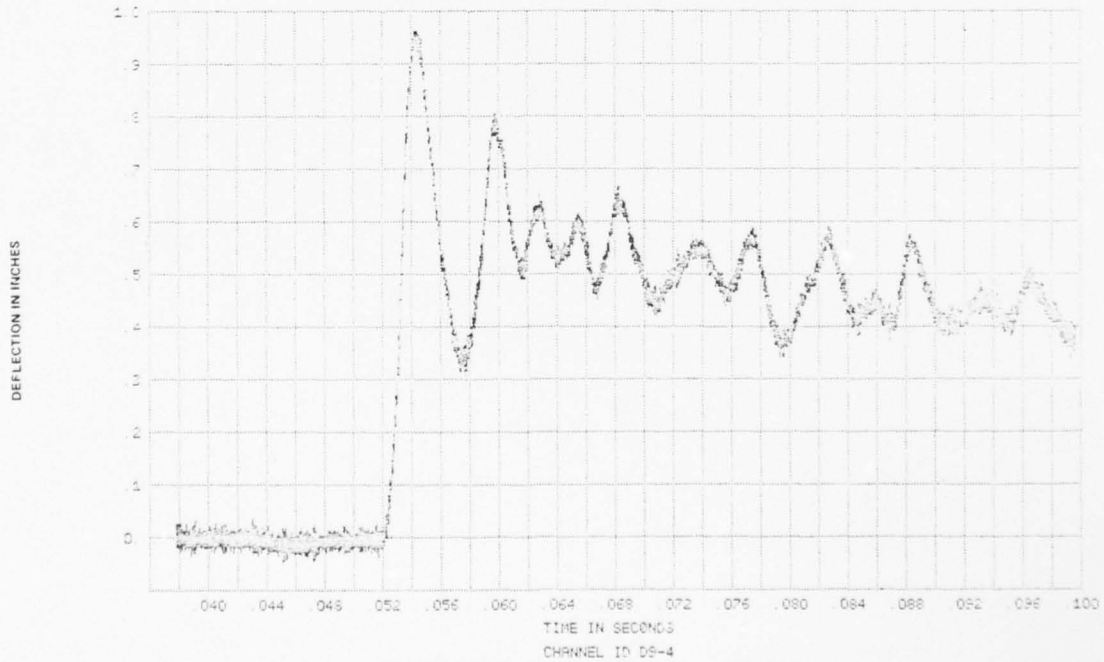


FIGURE 9-51 , SPECIMEN NO. 9 , SHOT NO. 4 , DEFLECTION TIME HISTORY

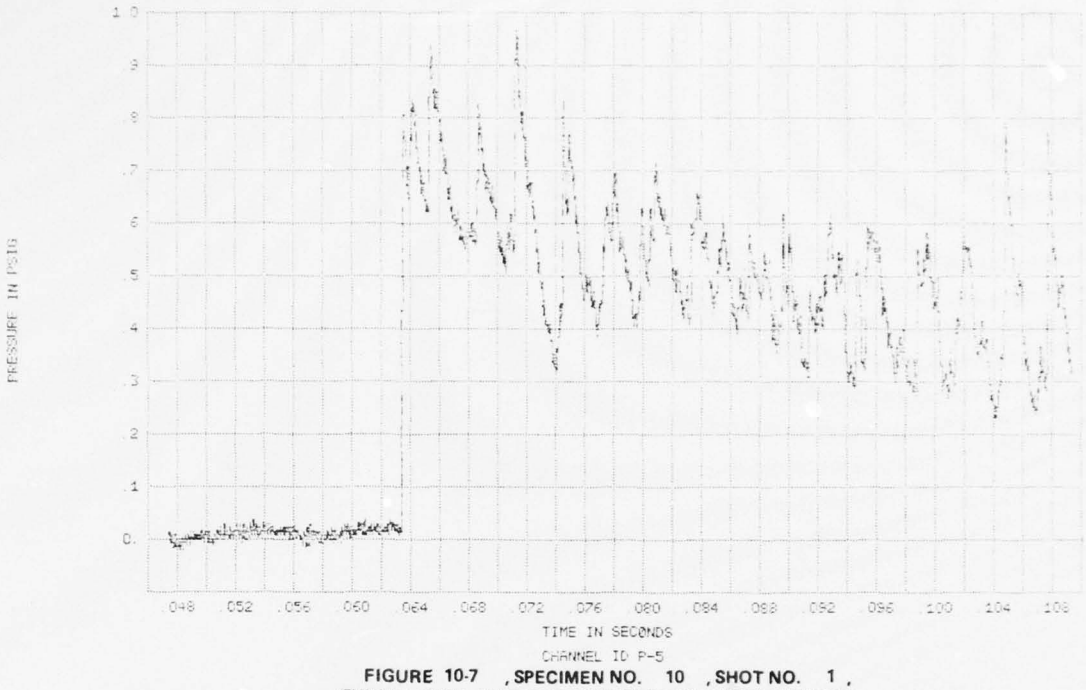


FIGURE 10-7 , SPECIMEN NO. 10 , SHOT NO. 1 , TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

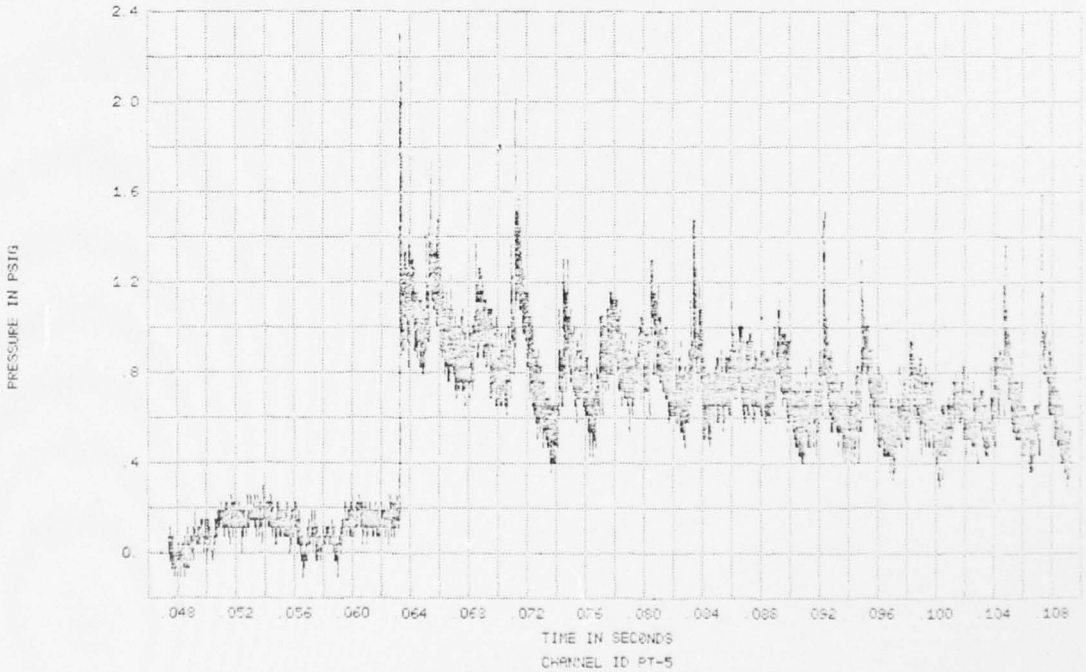


FIGURE 10-8 , SPECIMEN NO. 10 , SHOT NO. 1 , TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

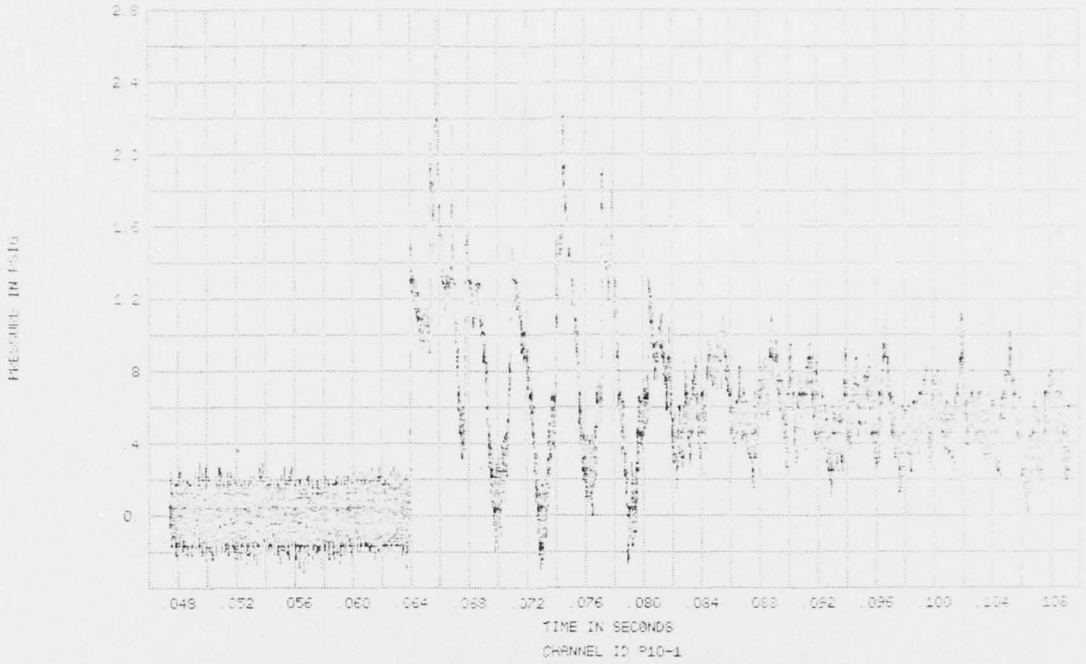


FIGURE 10-9 , SPECIMEN NO. 10 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

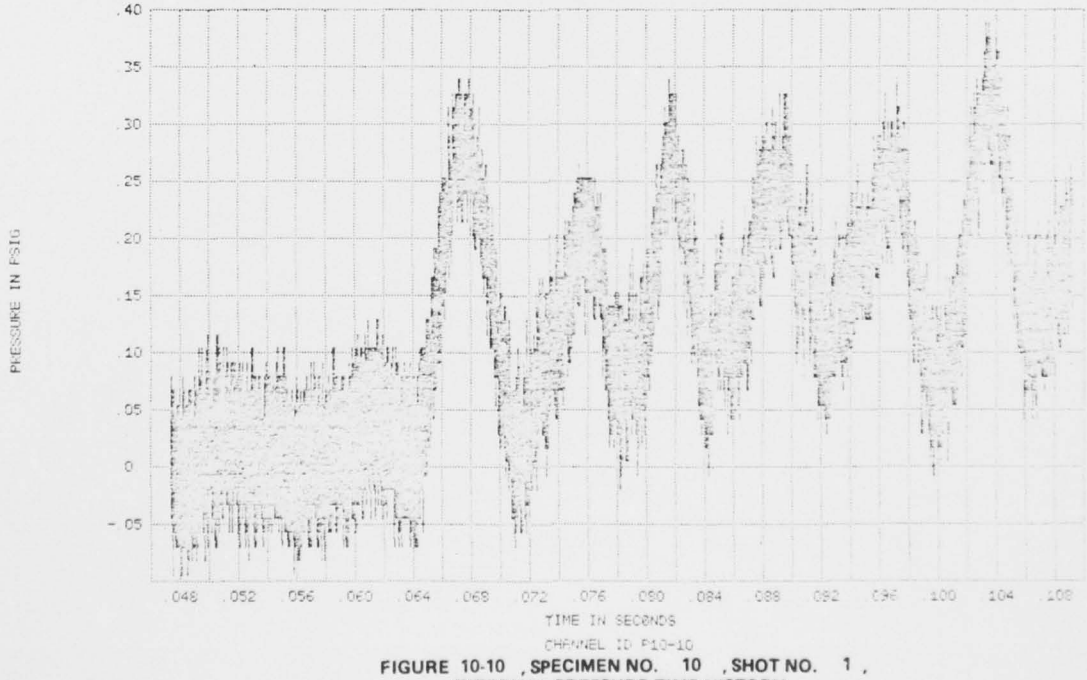


FIGURE 10-10 , SPECIMEN NO. 10 , SHOT NO. 1 ,
INTERNAL PRESSURE TIME HISTORY

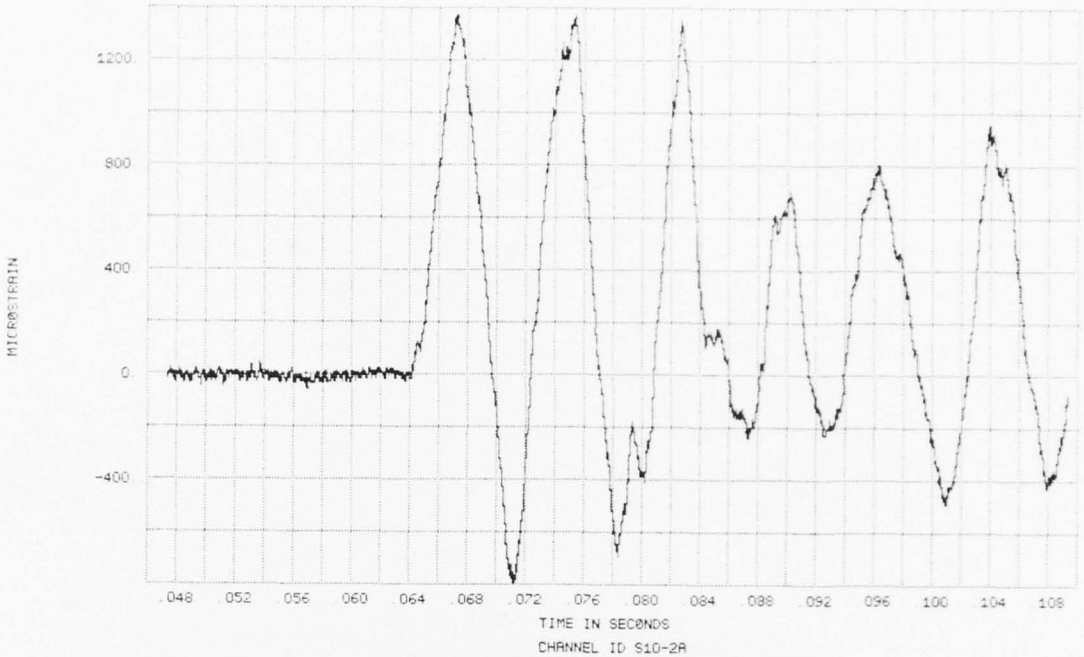


FIGURE 10-11 , SPECIMEN NO. 10 , SHOT NO. 1 ,
STRAIN TIME HiSTORY

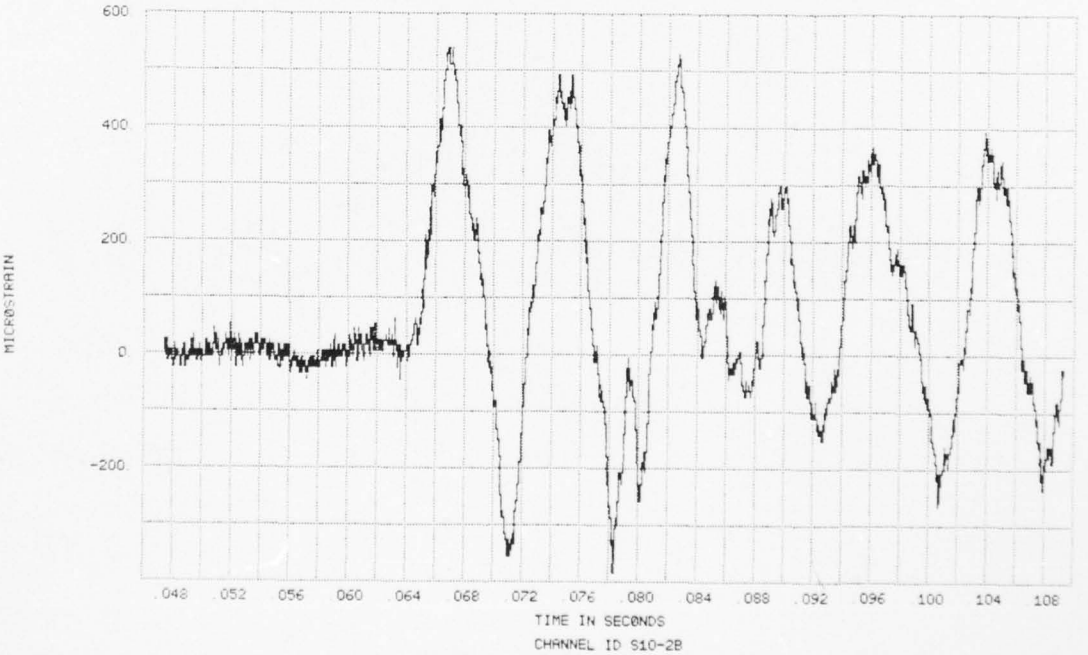


FIGURE 10-12 , SPECIMEN NO. 10 , SHOT NO. 1 ,
STRAIN TIME HISTORY

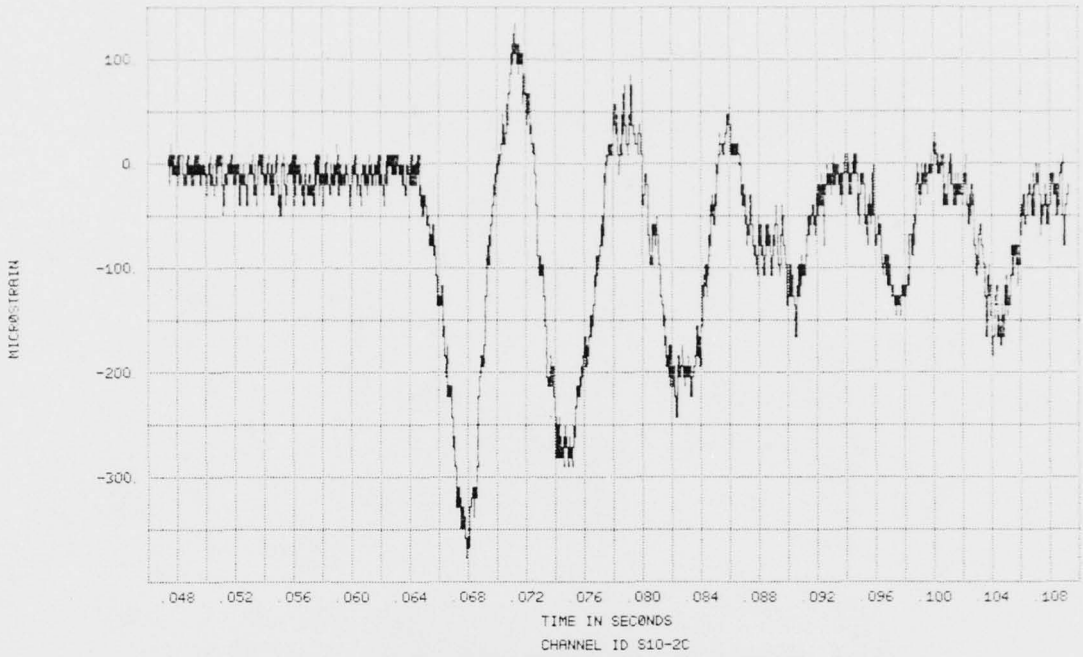


FIGURE 10-13 , SPECIMEN NO. 10 , SHOT NO. 1 ,
STRAIN TIME HISTORY

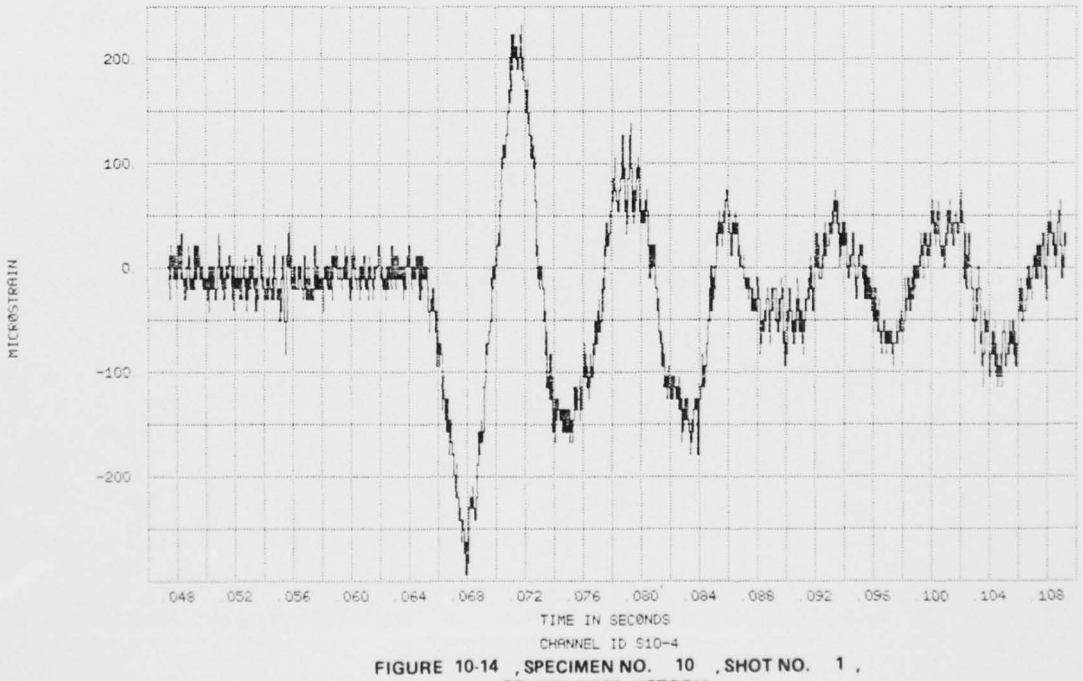


FIGURE 10-14 , SPECIMEN NO. 10 , SHOT NO. 1 ,
STRAIN TIME HISTORY

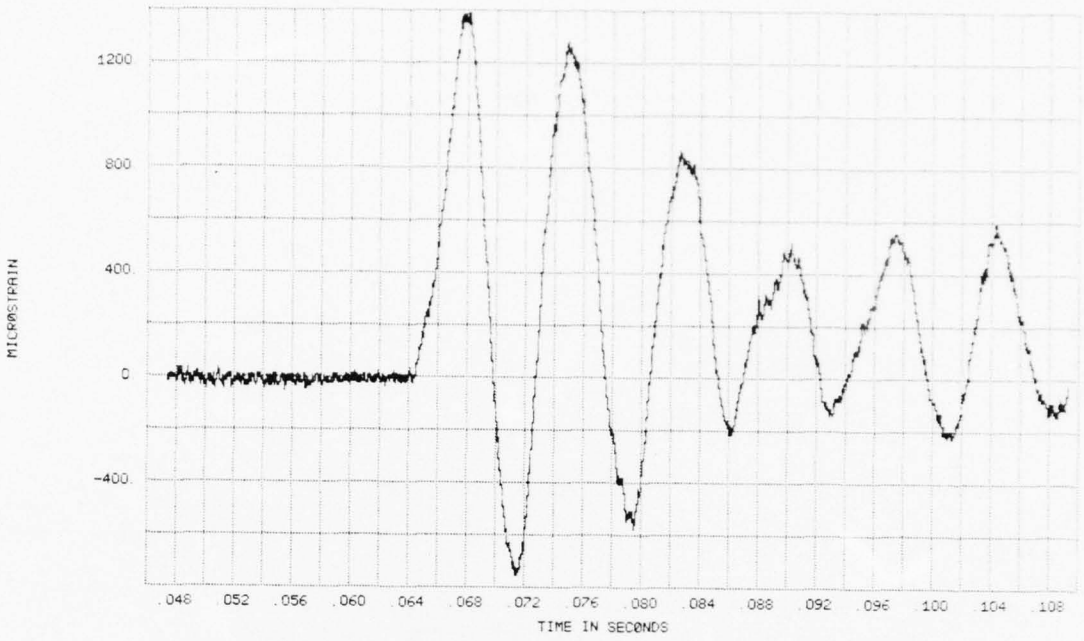


FIGURE 10-15 , SPECIMEN NO. 10 , SHOT NO. 1 , STRAIN TIME HISTORY

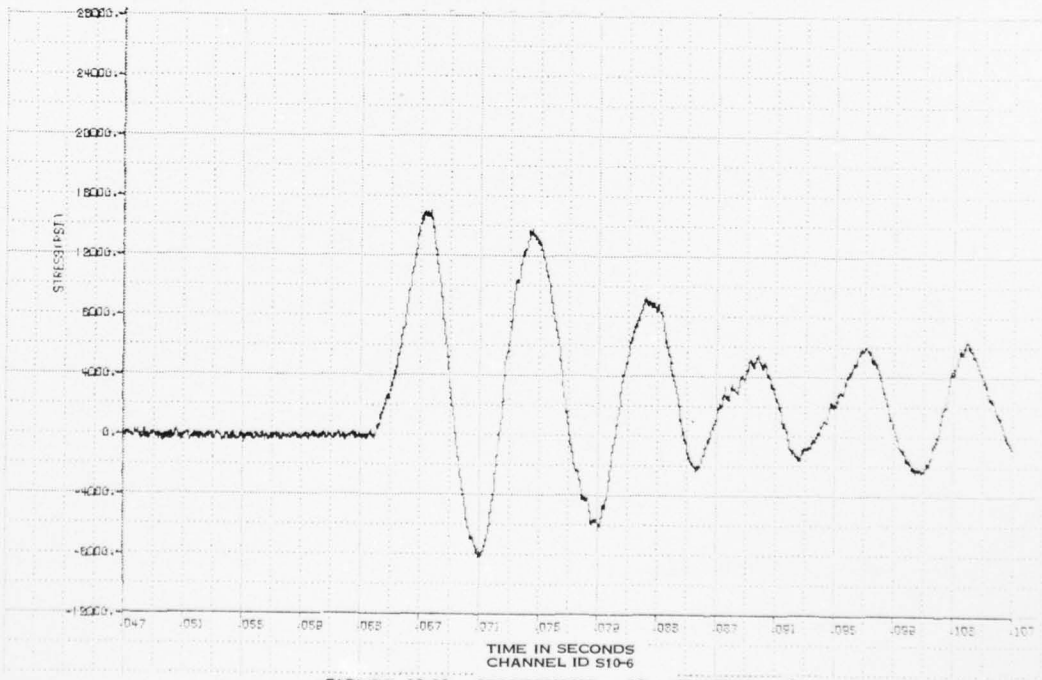


FIGURE 10-16 , SPECIMEN NO. 10 , SHOT NO. 1 , STRESS TIME HISTORY

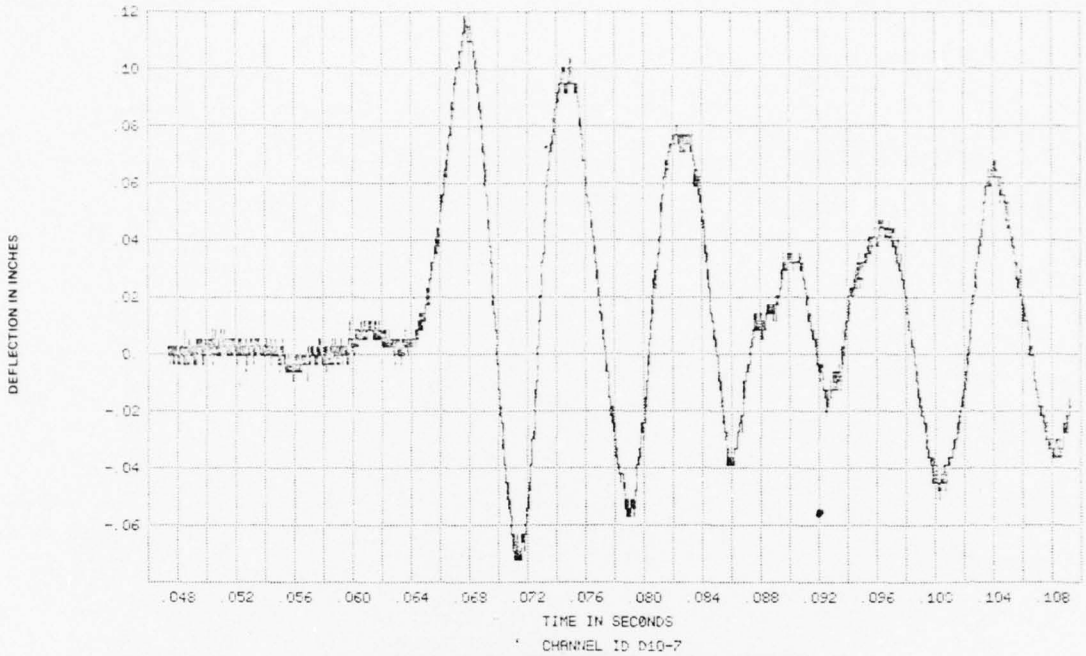


FIGURE 10-17 , SPECIMEN NO. 10 , SHOT NO. 1 , DEFLECTION TIME HISTORY

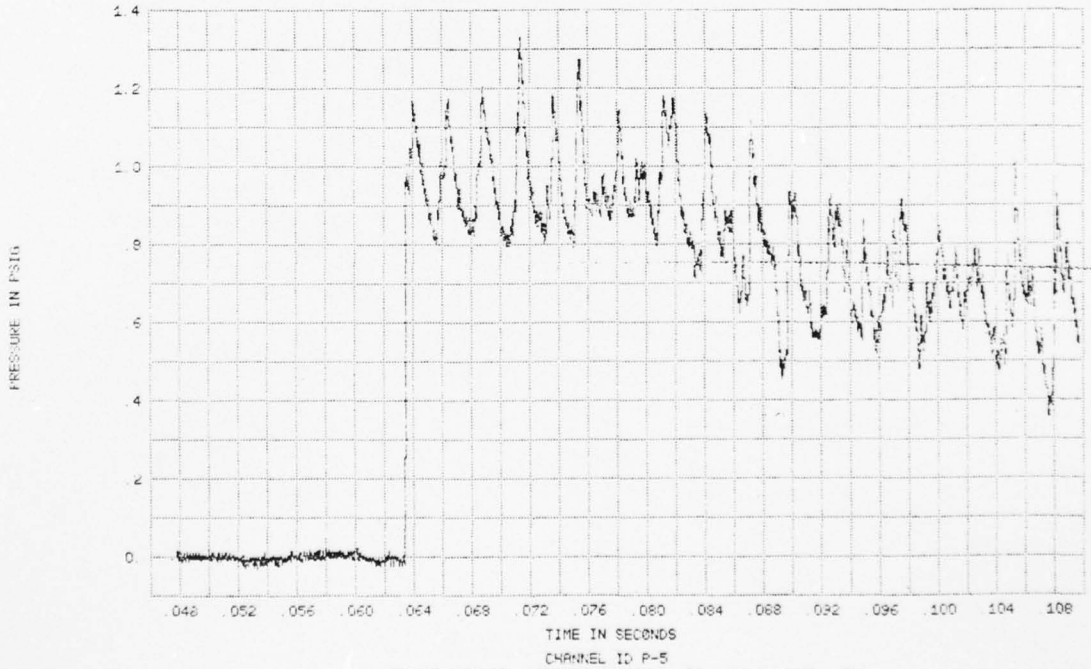


FIGURE 10-18 , SPECIMEN NO. 10 , SHOT NO. 2 , TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

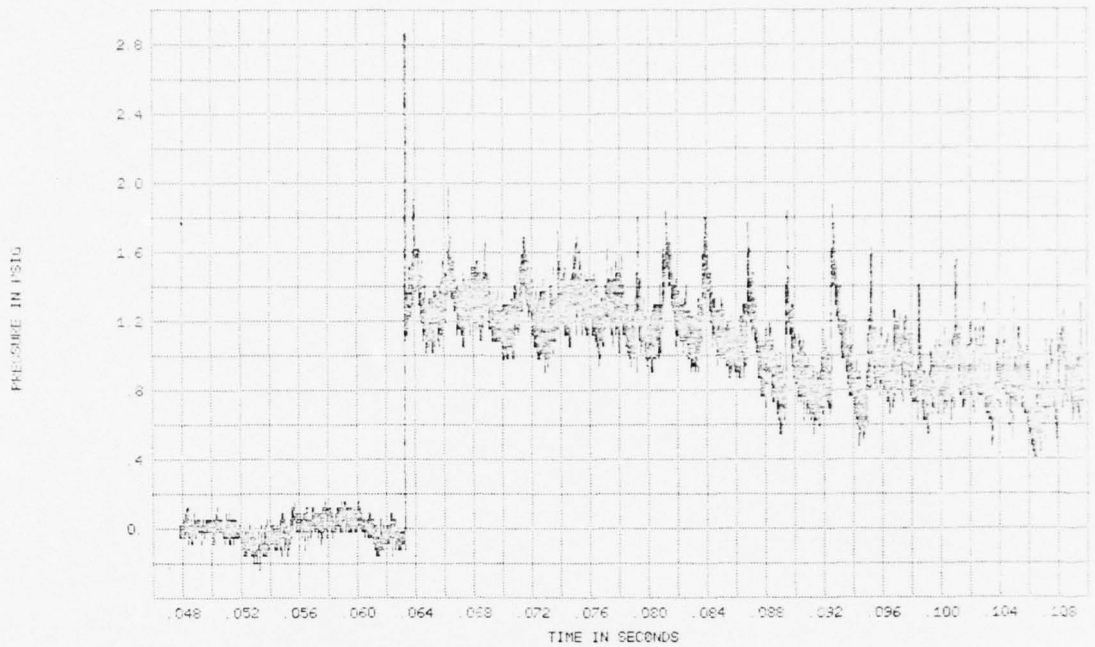


FIGURE 10-19 , SPECIMEN NO. 10 , SHOT NO. 2 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

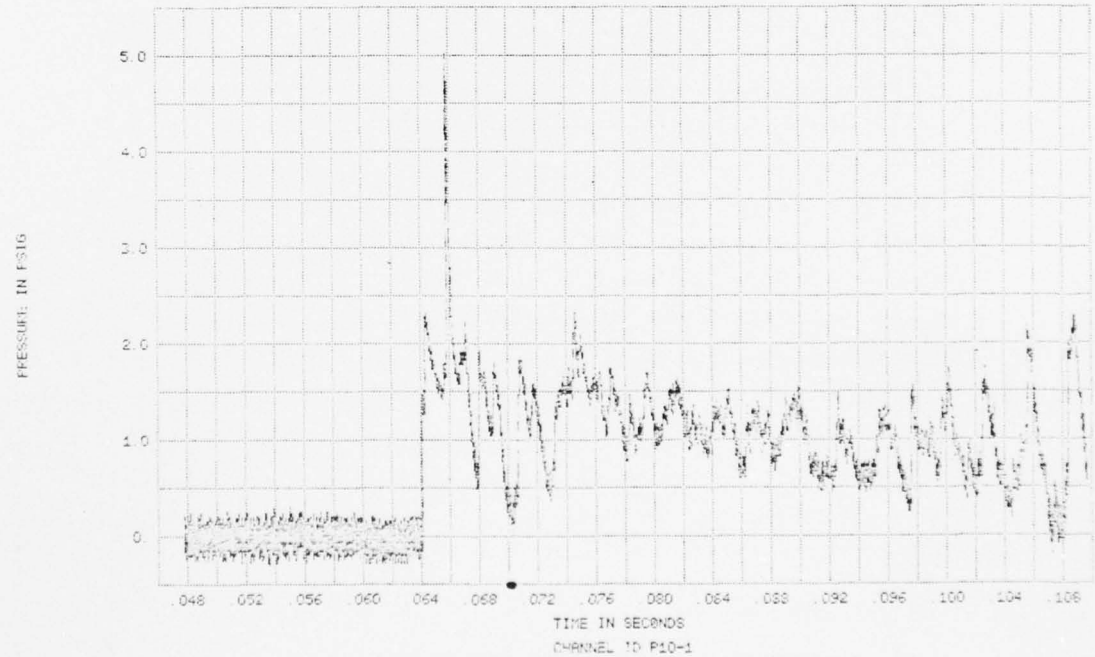


FIGURE 10-20 , SPECIMEN NO. 10 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

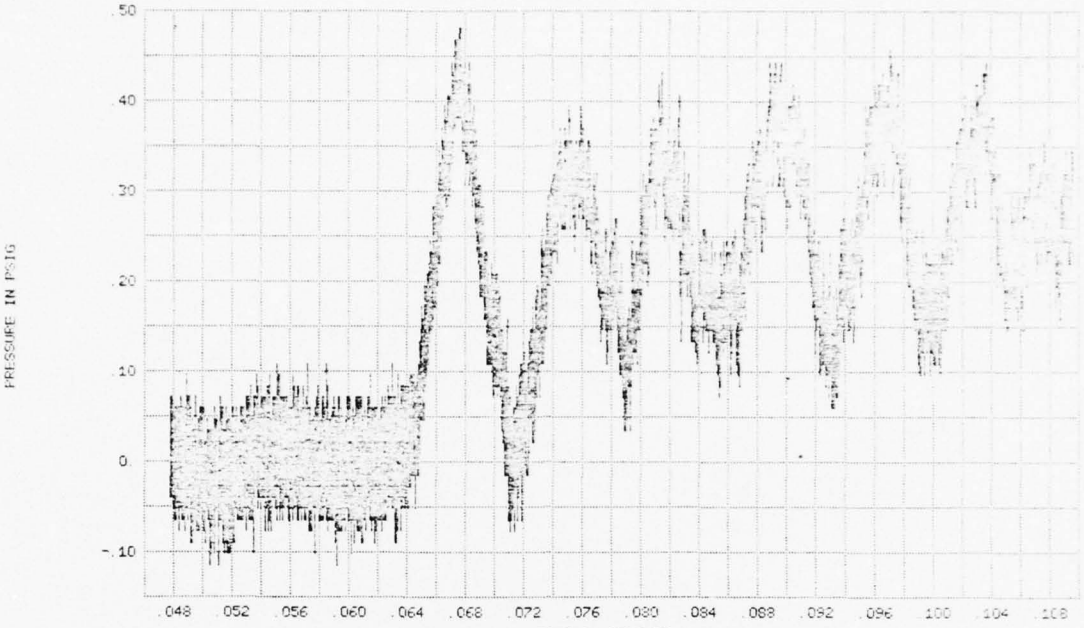


FIGURE 10-21 , SPECIMEN NO. 10 , SHOT NO. 2 ,
INTERNAL PRESSURE TIME HISTORY

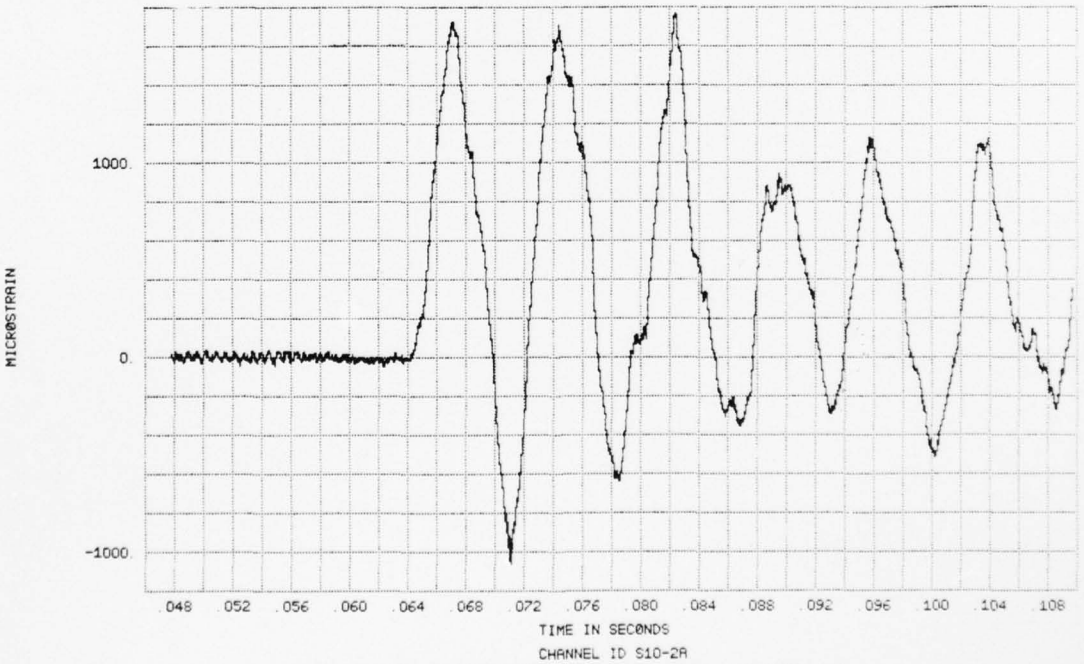


FIGURE 10-22 , SPECIMEN NO. 10 , SHOT NO. 2 ,
STRAIN TIME HISTORY

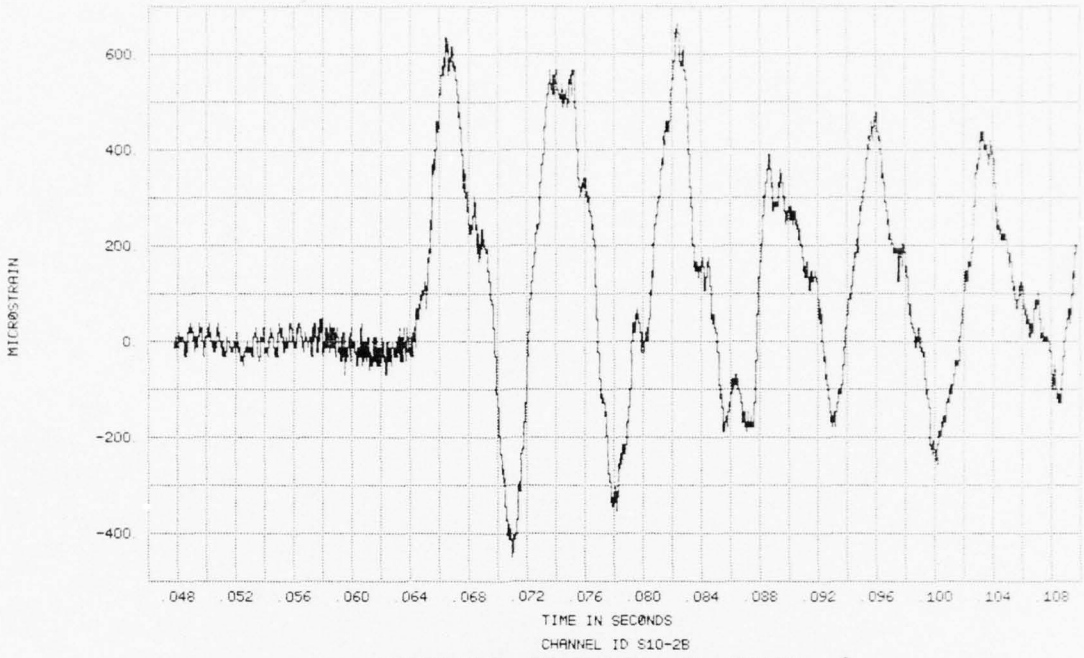


FIGURE 10-23 , SPECIMEN NO. 10 , SHOT NO. 2 , STRAIN TIME HISTORY

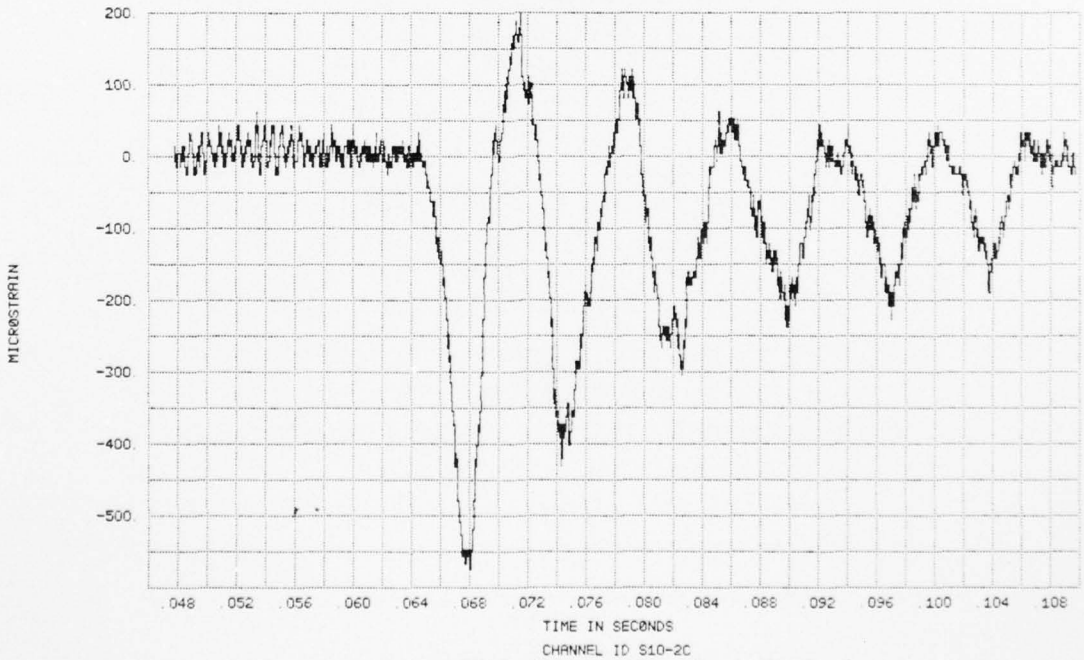


FIGURE 10-24 , SPECIMEN NO. 10 , SHOT NO. 2 , STRAIN TIME HISTORY

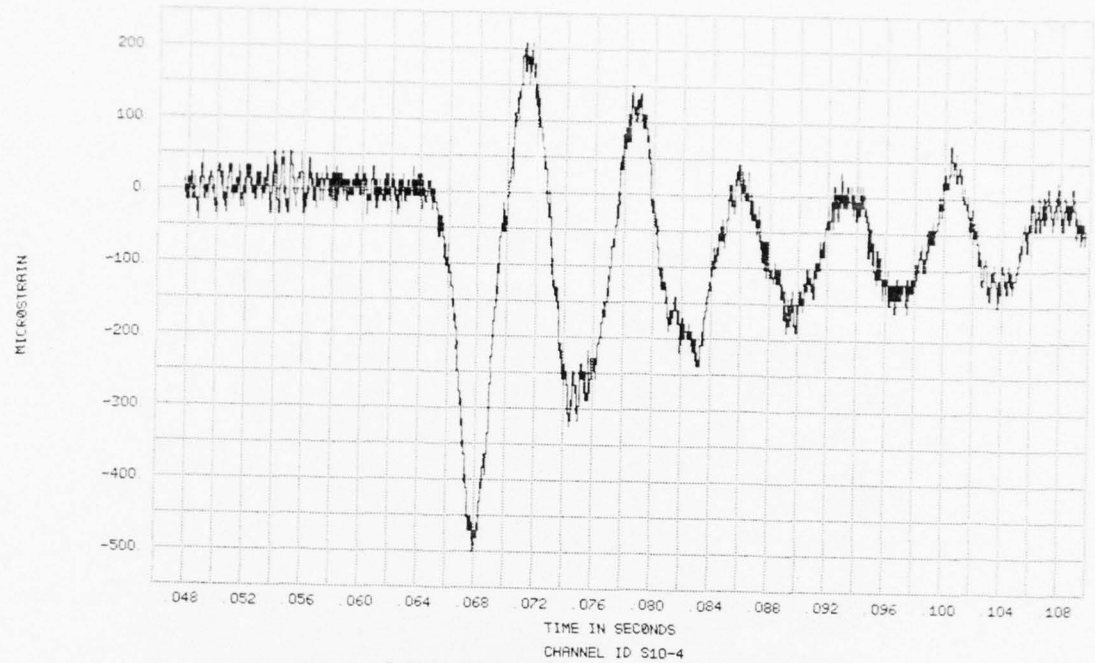


FIGURE 10-25 , SPECIMEN NO. 10 , SHOT NO. 2 ,
STRAIN TIME HISTORY

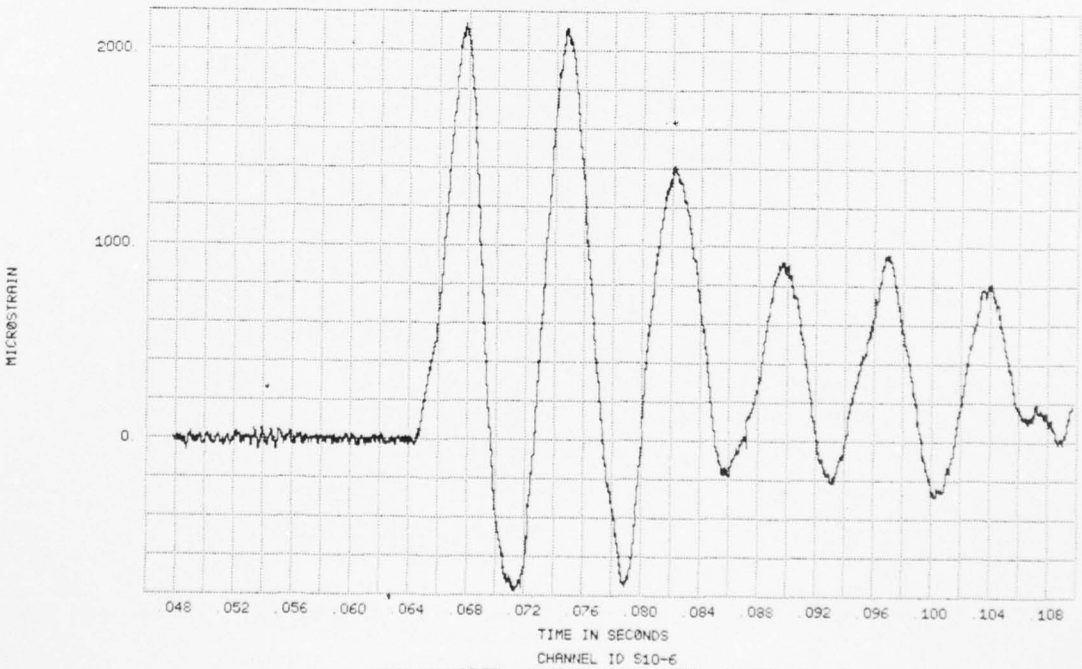


FIGURE 10-26 , SPECIMEN NO. 10 , SHOT NO. 2 ,
STRAIN TIME HISTORY

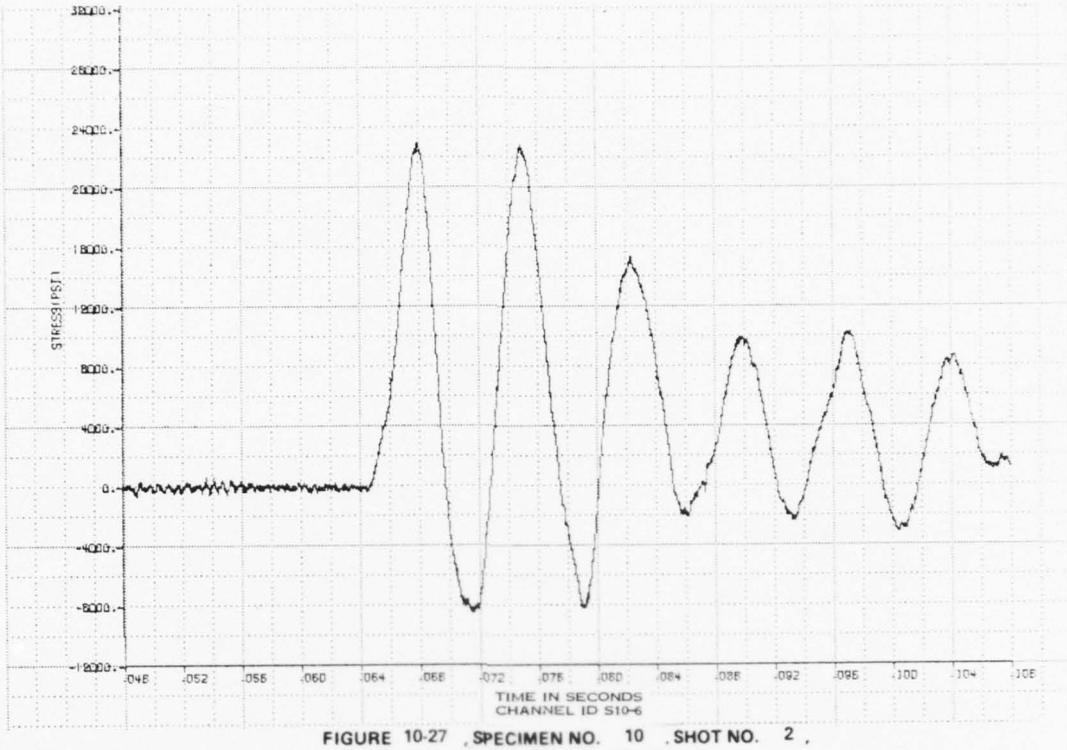


FIGURE 10-27 , SPECIMEN NO. 10 , SHOT NO. 2 ,
STRESS TIME HISTORY

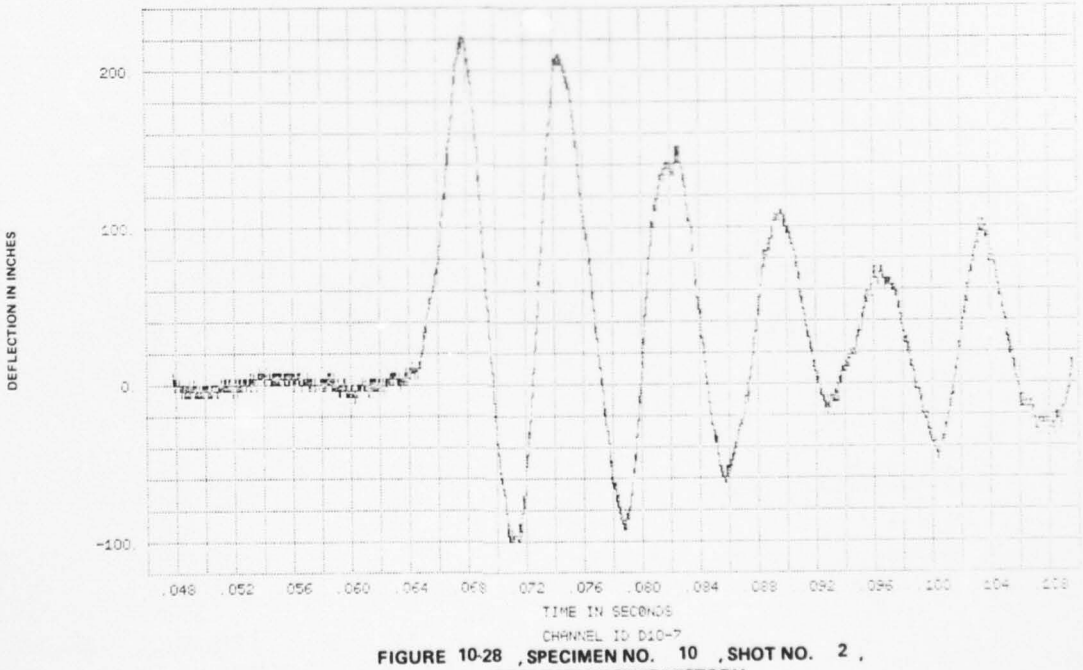


FIGURE 10-28 , SPECIMEN NO. 10 , SHOT NO. 2 ,
DEFLECTION TIME HISTORY

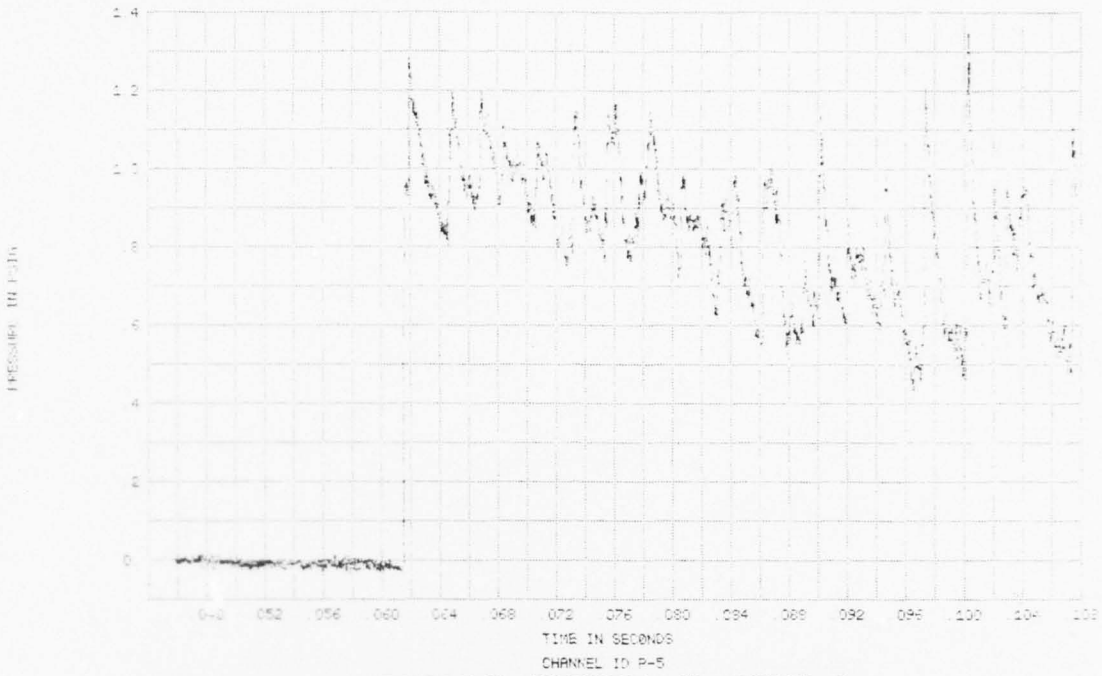


FIGURE 10-29 , SPECIMEN NO. 10 , SHOT NO. 3 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

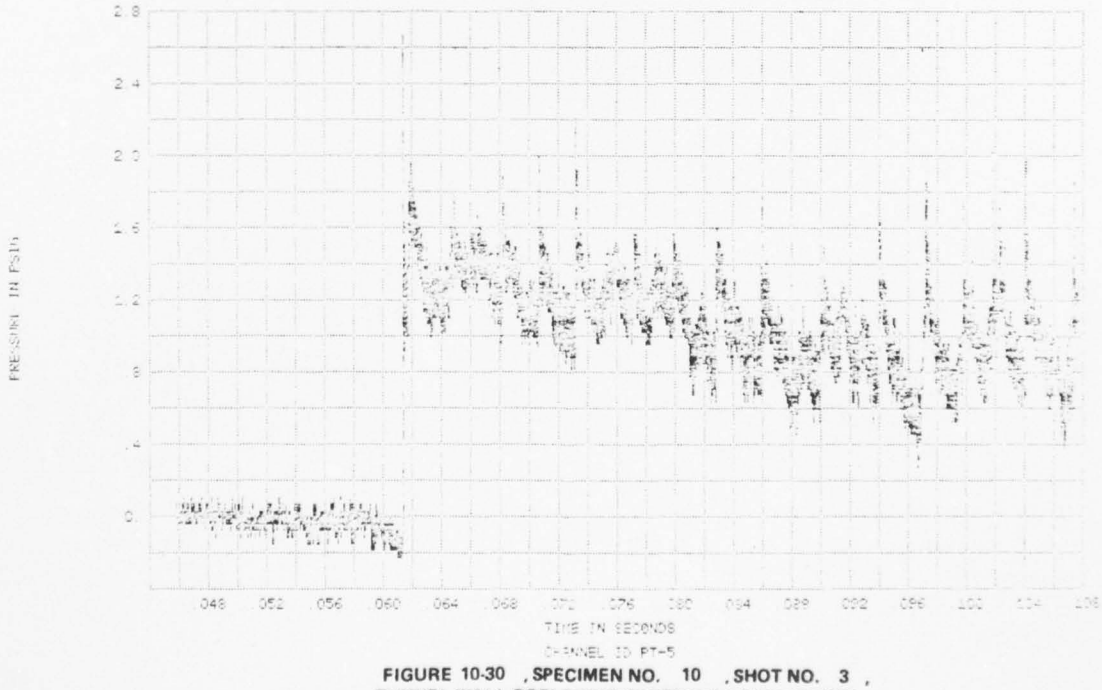


FIGURE 10-30 , SPECIMEN NO. 10 , SHOT NO. 3 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

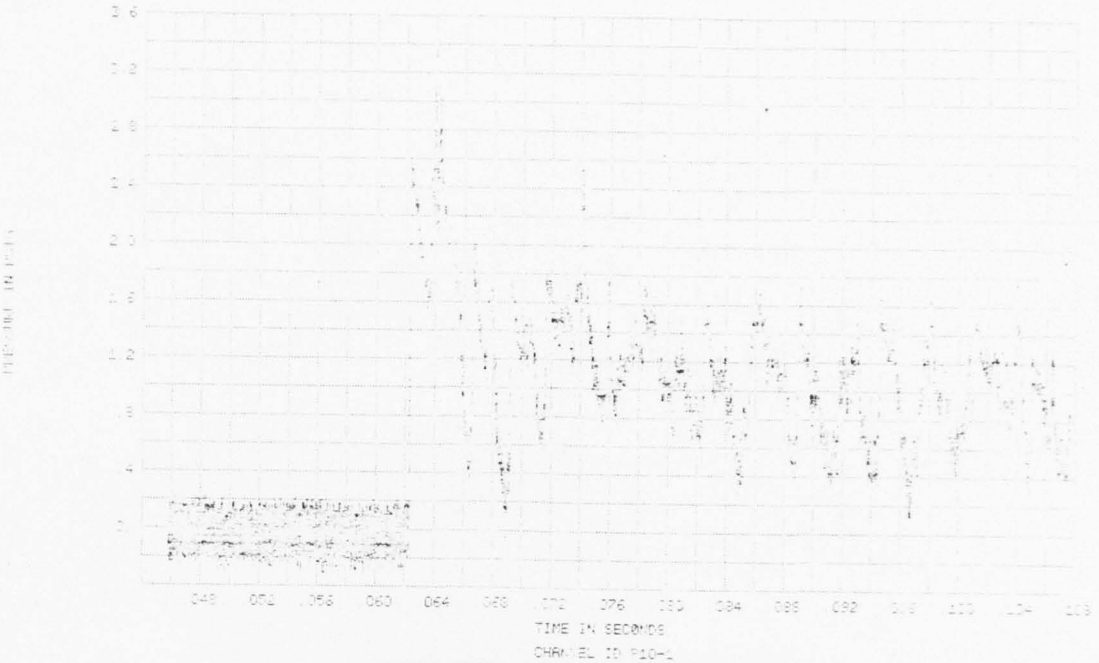


FIGURE 10-31 , SPECIMEN NO. 10 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

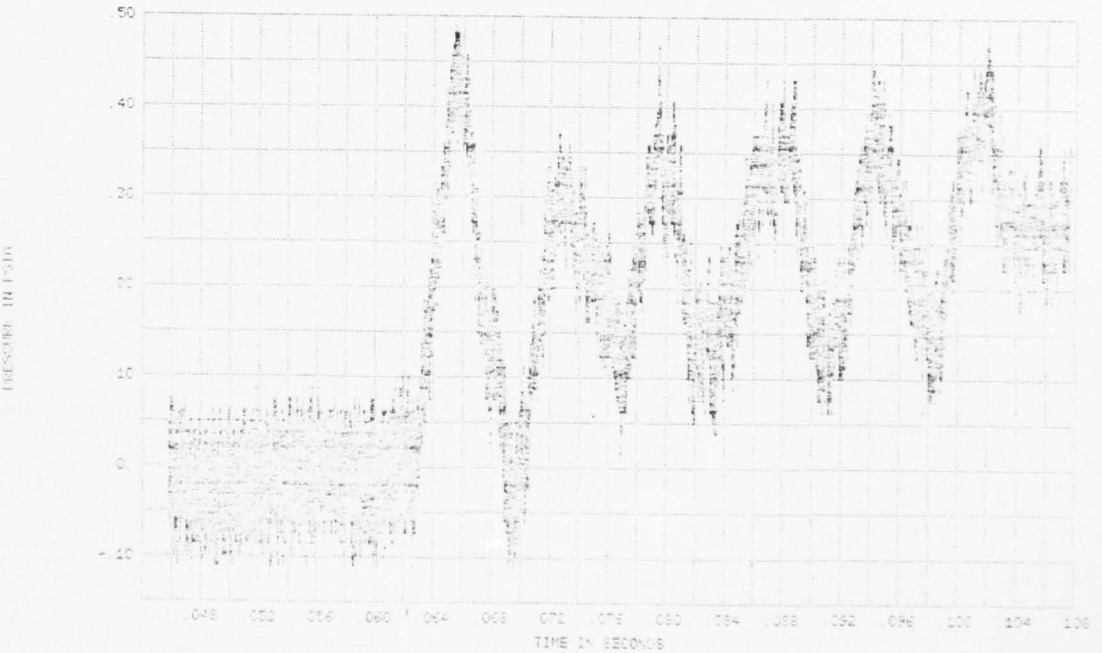


FIGURE 10-32 , SPECIMEN NO. 10 , SHOT NO. 3 ,
INTERNAL PRESSURE TIME HISTORY

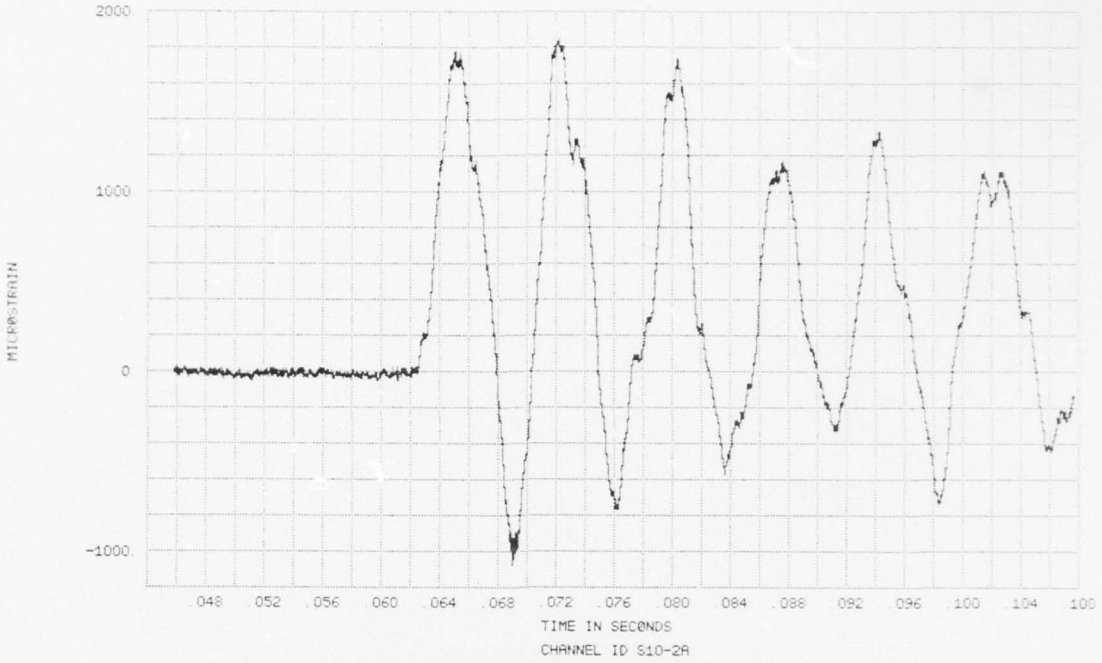


FIGURE 10-33 , SPECIMEN NO. 10 , SHOT NO. 3 ,
STRAIN TIME HISTORY

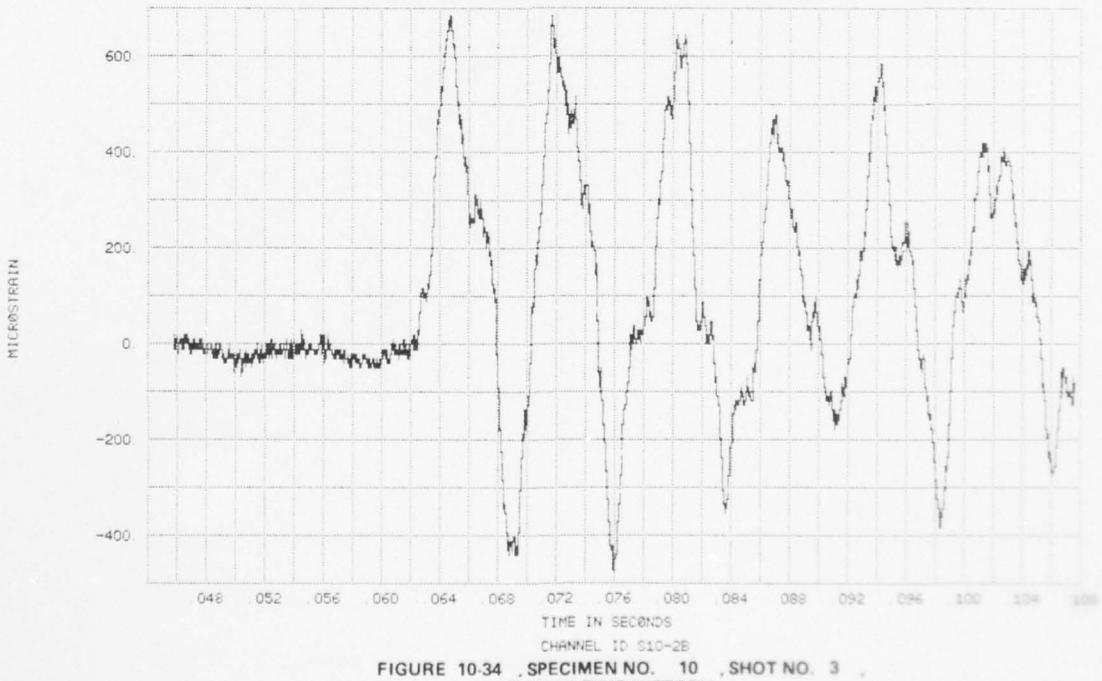
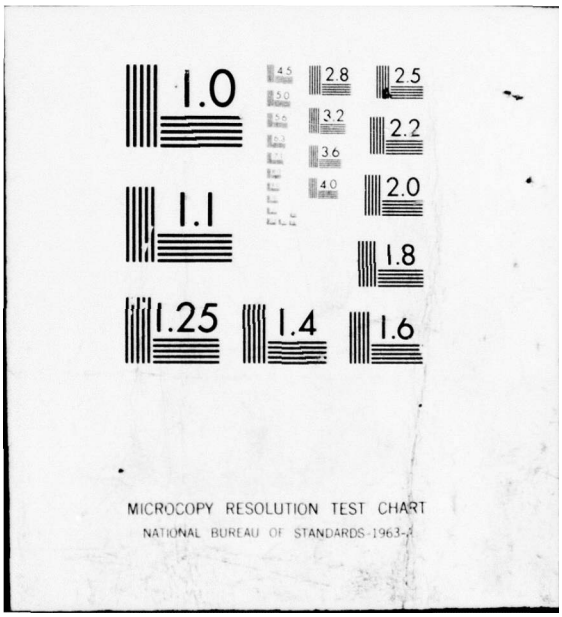


FIGURE 10-34 , SPECIMEN NO. 10 , SHOT NO. 3 ,
STRAIN TIME HISTORY

AD-A052 029 BOEING WICHITA CO KS F/G 18/3
STRUCTURAL RESPONSE TO SIMULATED NUCLEAR OVERPRESSURE (STRESNO)--ETC(U)
MAR 77 R P SYRING, W D PIERSON DNA001-76-C-0084
UNCLASSIFIED D3-9788-5-VOL-2 DNA-4278F-2 NL

6 OF 8
AD A052 029




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

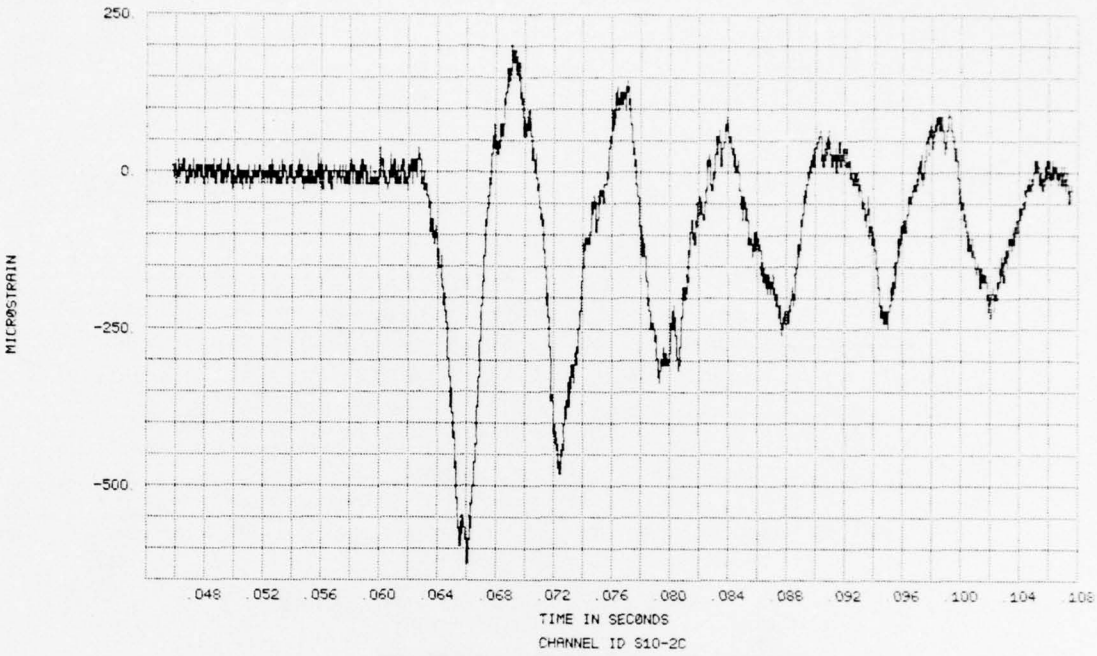


FIGURE 10-35 , SPECIMEN NO. 10 , SHOT NO. 3 ,
STRAIN TIME HISTORY

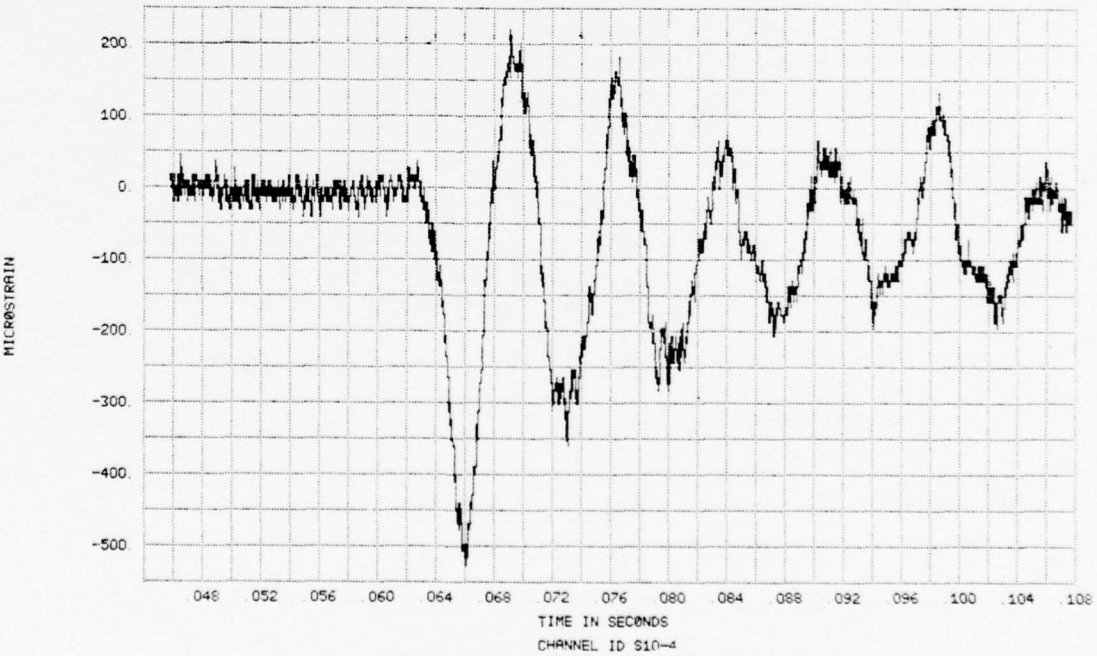


FIGURE 10-36 , SPECIMEN NO. 10 , SHOT NO. 3 ,
STRAIN TIME HISTORY

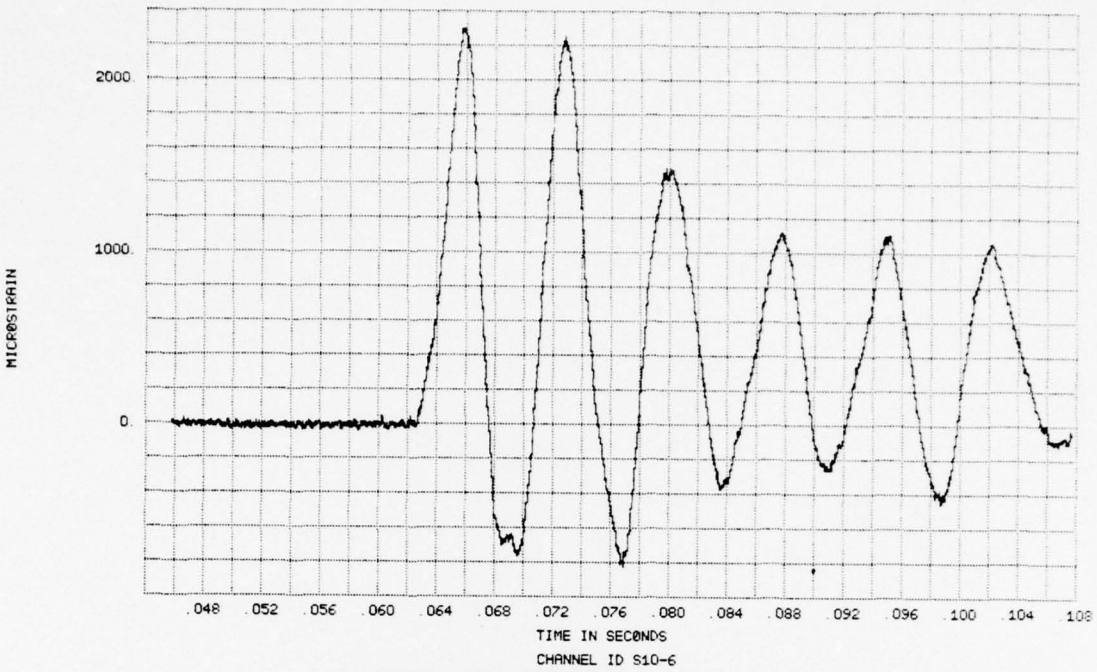


FIGURE 10-37 , SPECIMEN NO. 10 . SHOT NO. 3 ,
STRAIN TIME HISTORY

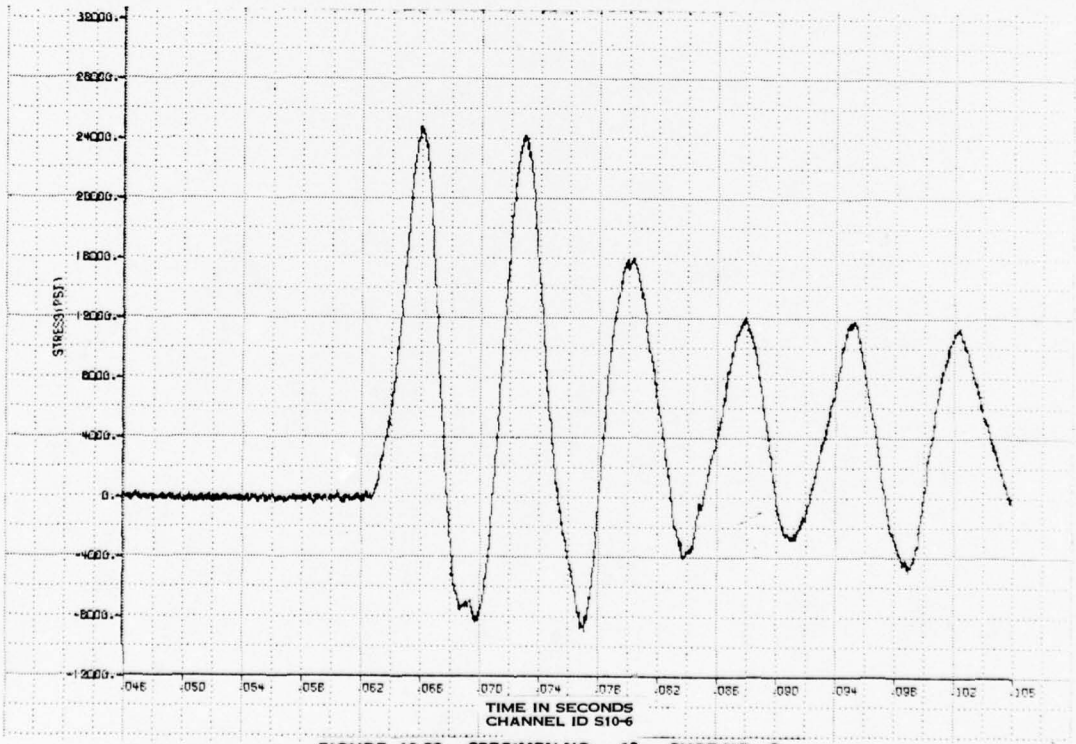


FIGURE 10-38 , SPECIMEN NO. 10 , SHOT NO. 3 ,
STRESS TIME HISTORY

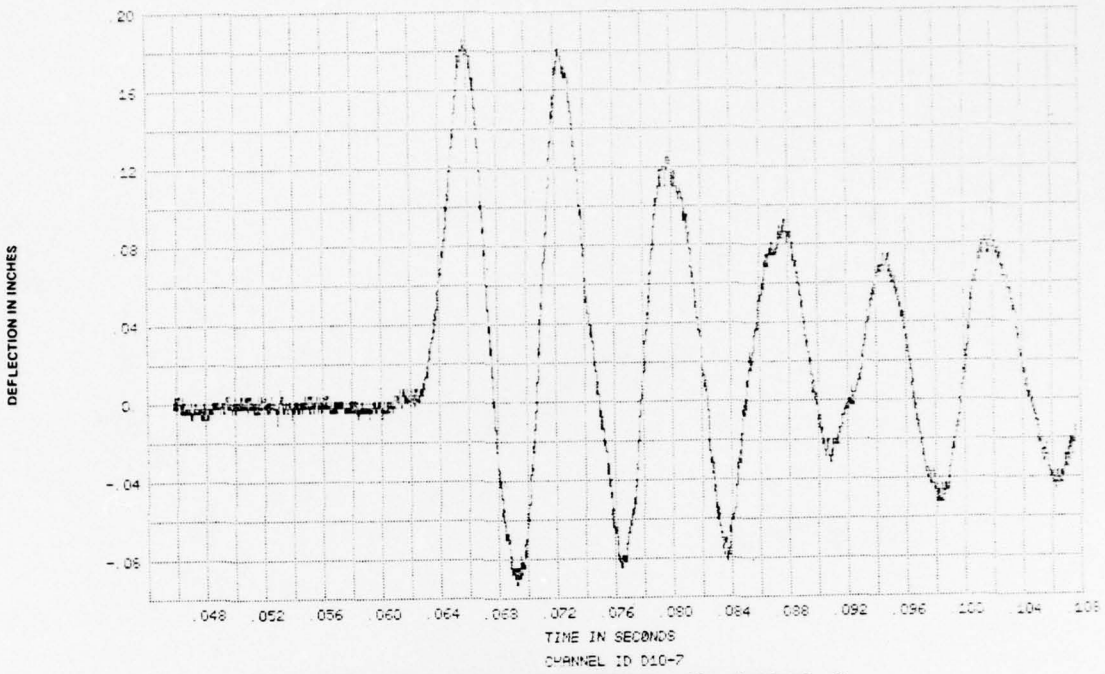


FIGURE 10-39 , SPECIMEN NO. 10 , SHOT NO. 3 , DEFLECTION TIME HISTORY

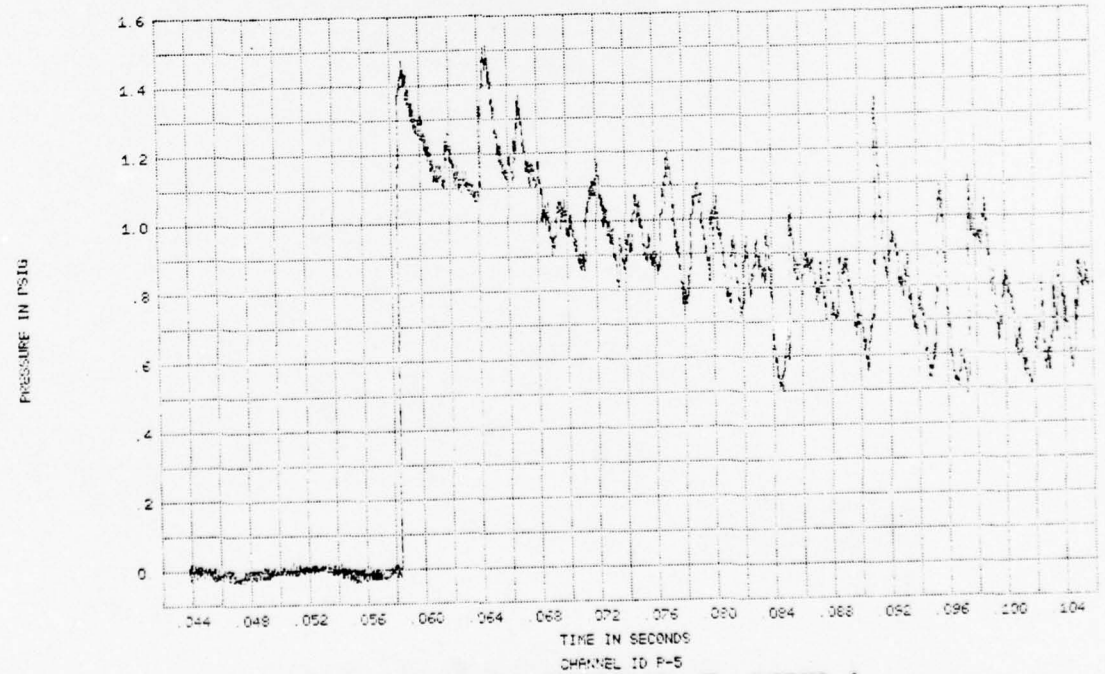


FIGURE 10-40 , SPECIMEN NO. 10 , SHOT NO. 4 , TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

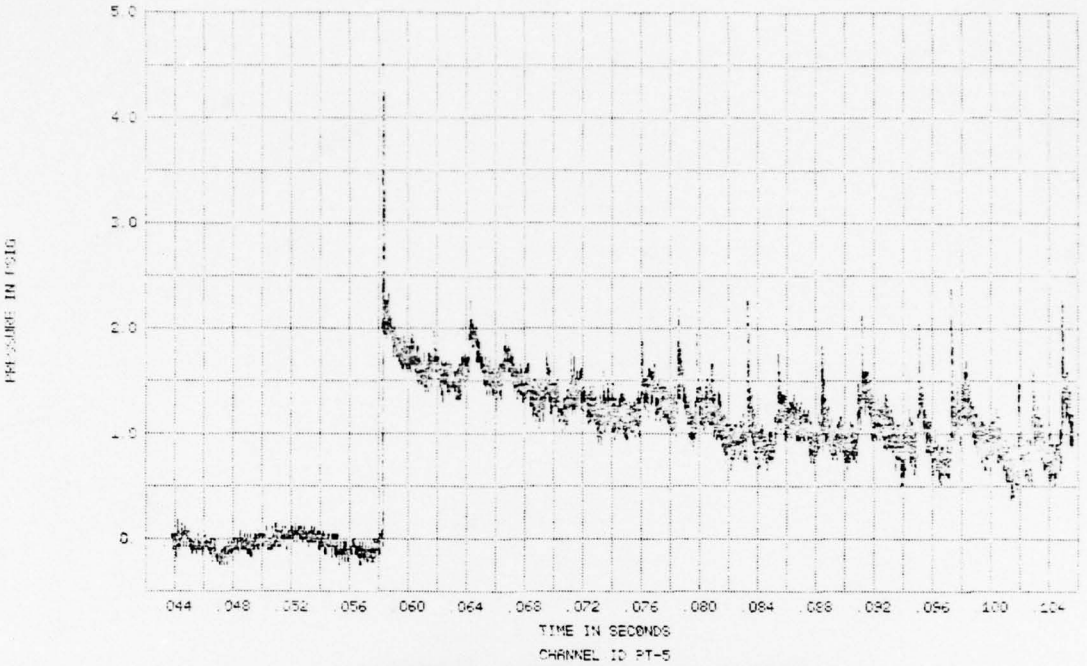


FIGURE 10-41 , SPECIMEN NO. 10 , SHOT NO. 4 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

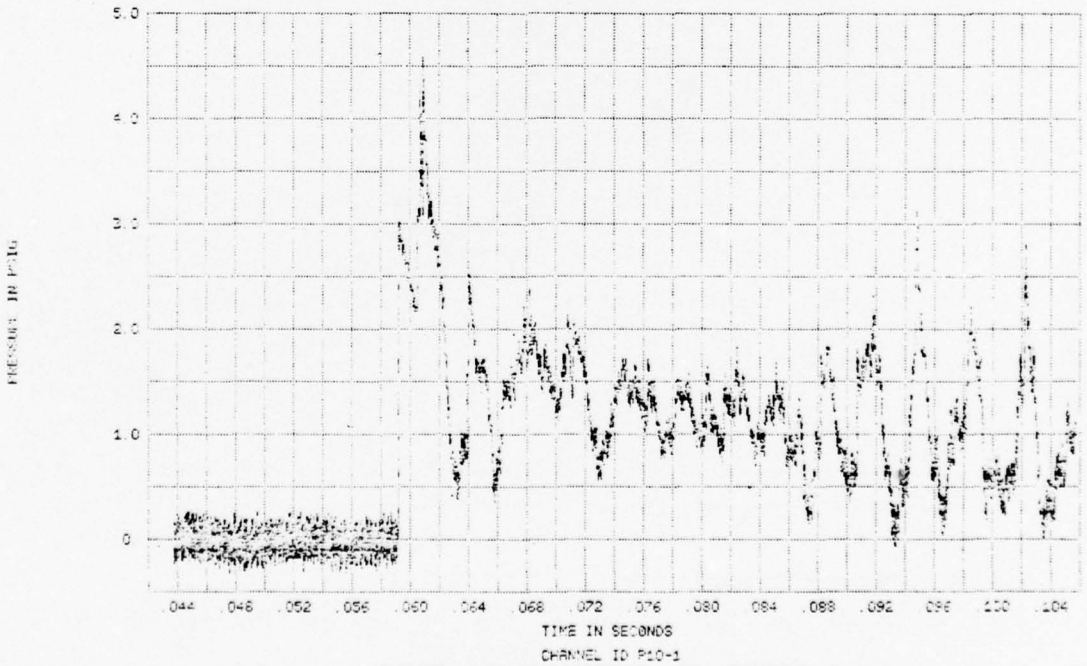


FIGURE 10-42 , SPECIMEN NO. 10 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

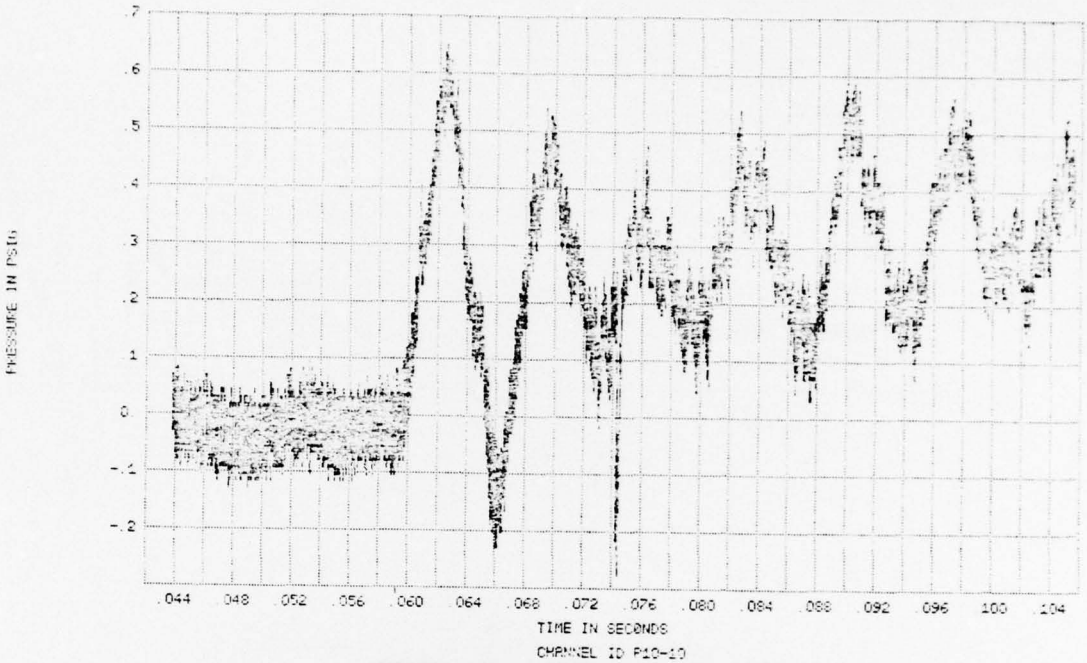


FIGURE 10-43 , SPECIMEN NO. 10 , SHOT NO. 4 ,
INTERNAL PRESSURE TIME HISTORY

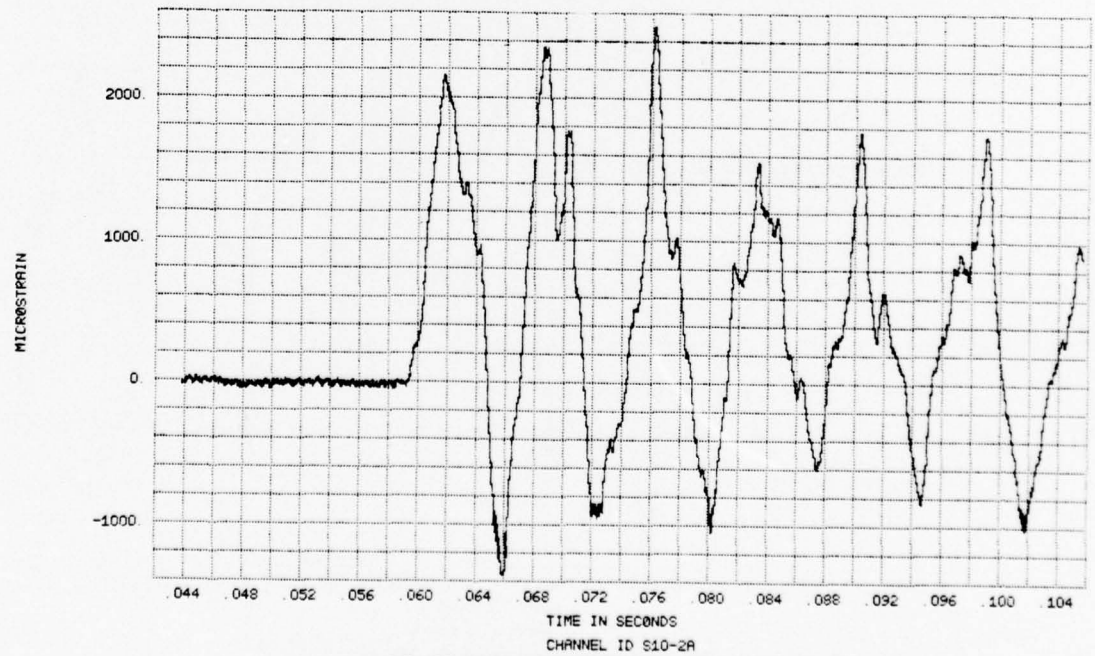


FIGURE 10-44 , SPECIMEN NO. 10 , SHOT NO. 4 ,
STRAIN TIME HISTORY

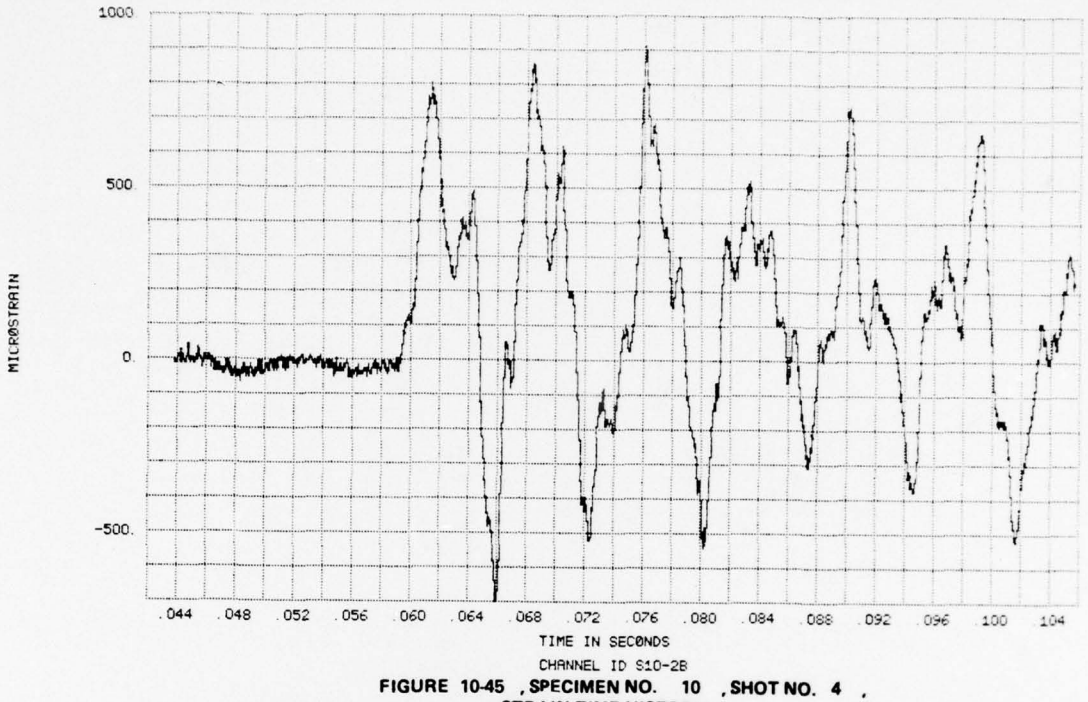


FIGURE 10-45 , SPECIMEN NO. 10 , SHOT NO. 4 ,
STRAIN TIME HISTORY

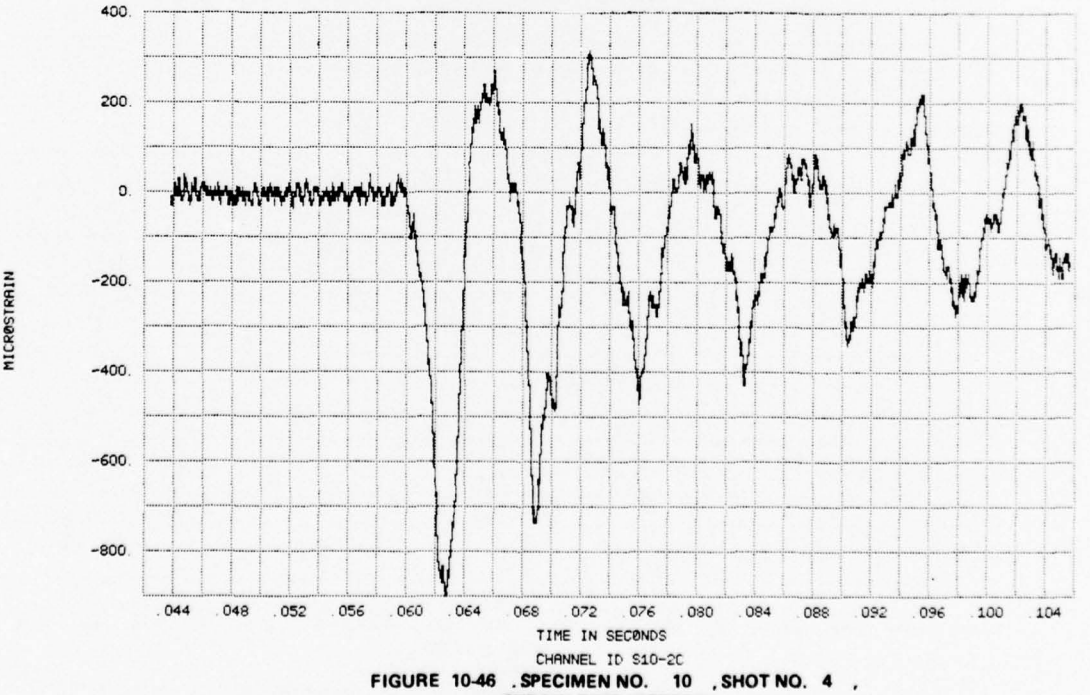


FIGURE 10-46 , SPECIMEN NO. 10 , SHOT NO. 4 ,
STRAIN TIME HISTORY

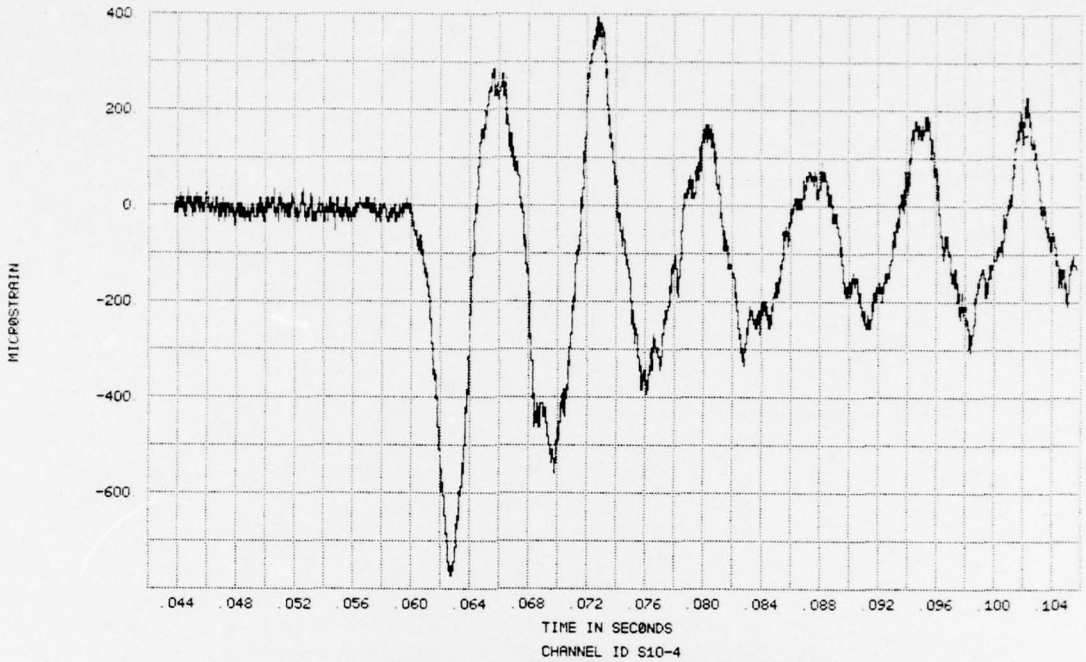


FIGURE 10-47 , SPECIMEN NO. 10 , SHOT NO. 4 , STRAIN TIME HISTORY

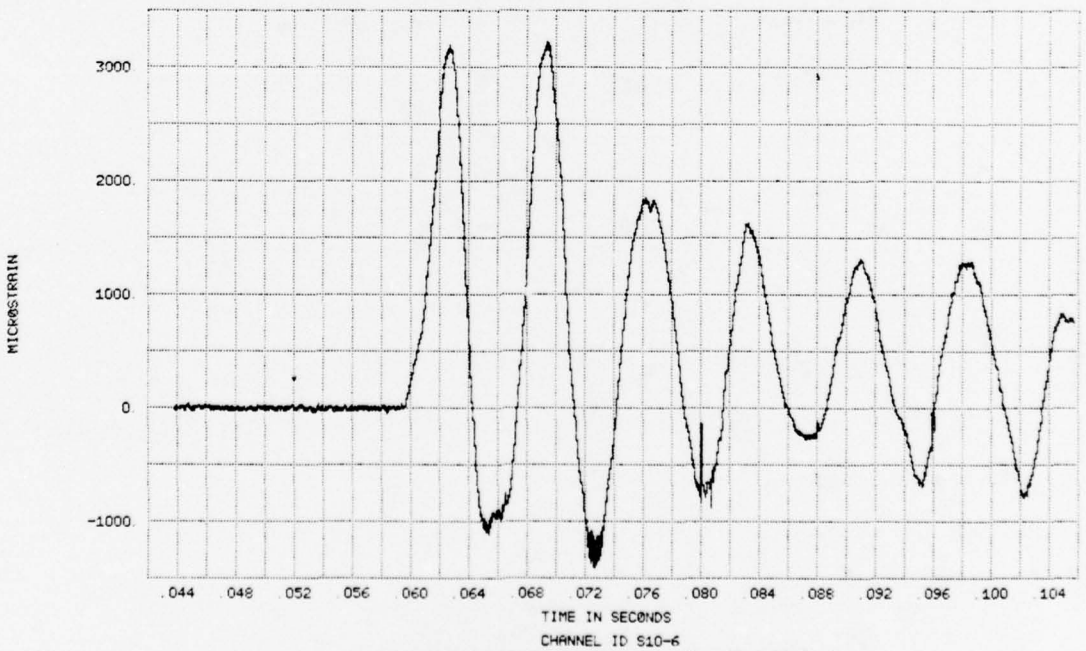


FIGURE 10-48 , SPECIMEN NO. 10 , SHOT NO. 4 , STRAIN TIME HISTORY

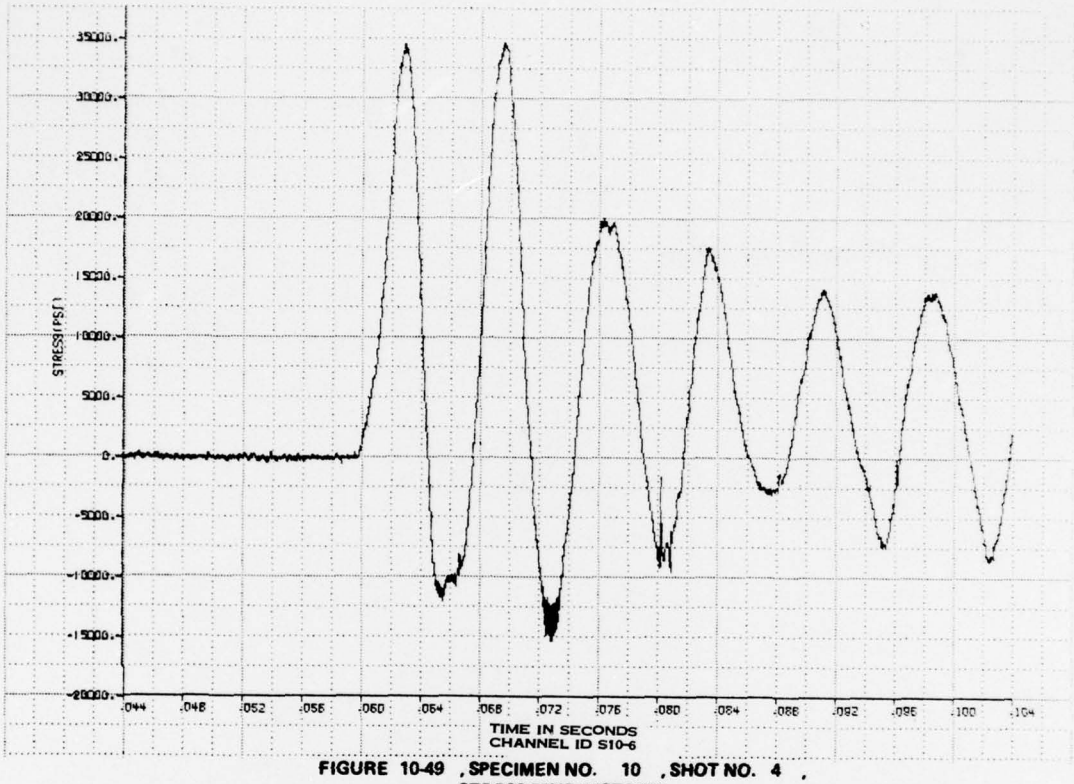


FIGURE 10-49 , SPECIMEN NO. 10 , SHOT NO. 4 ,
STRESS TIME HISTORY

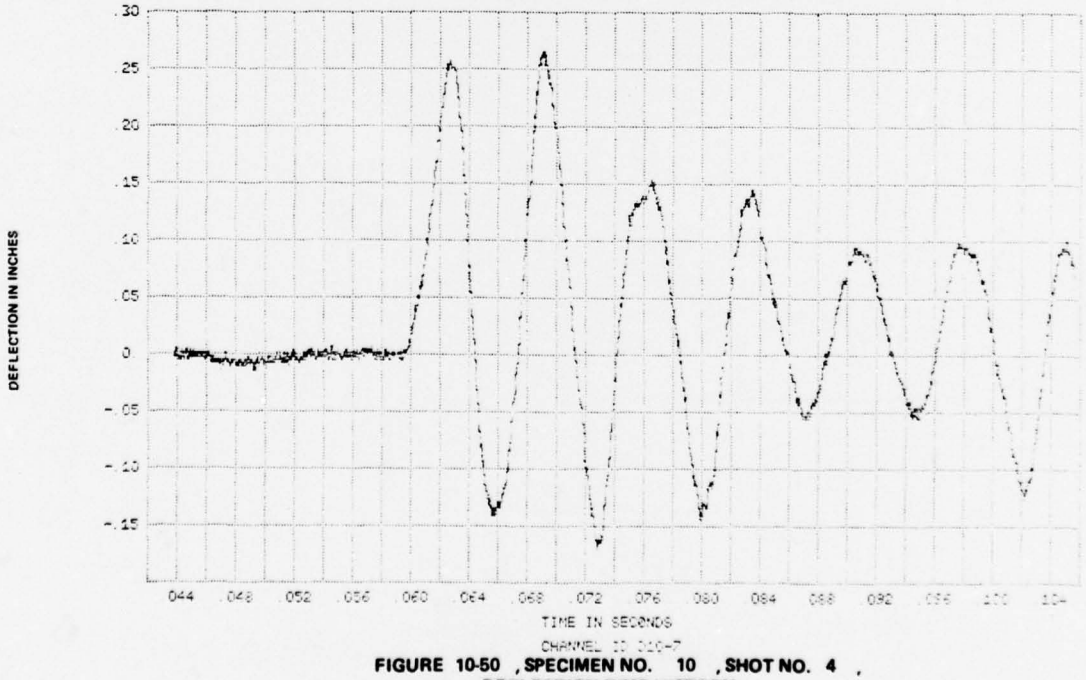


FIGURE 10-50 , SPECIMEN NO. 10 , SHOT NO. 4 ,
DEFLECTION TIME HISTORY

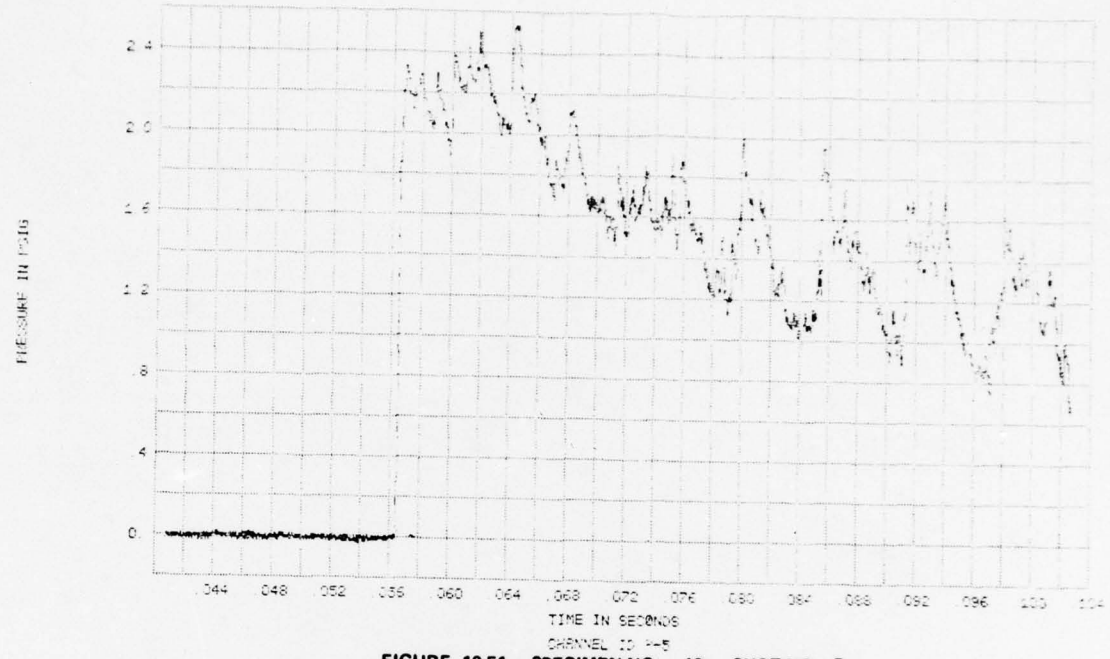


FIGURE 10-51 , SPECIMEN NO. 10 , SHOT NO. 5 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

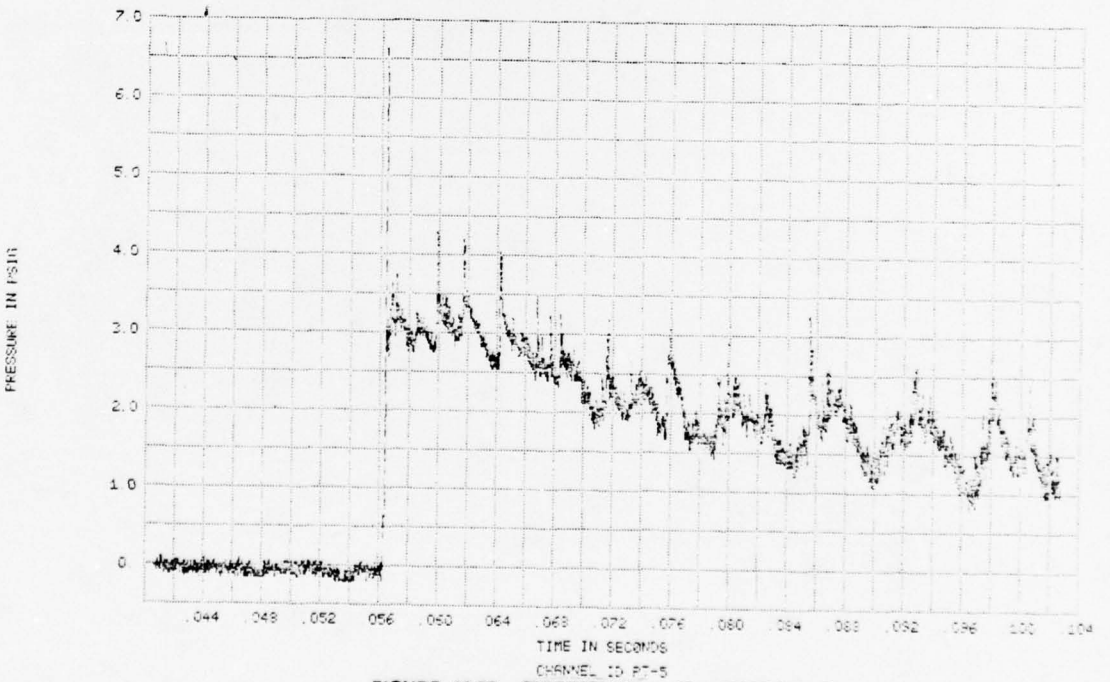


FIGURE 10-52 , SPECIMEN NO. 10 , SHOT NO. 5 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

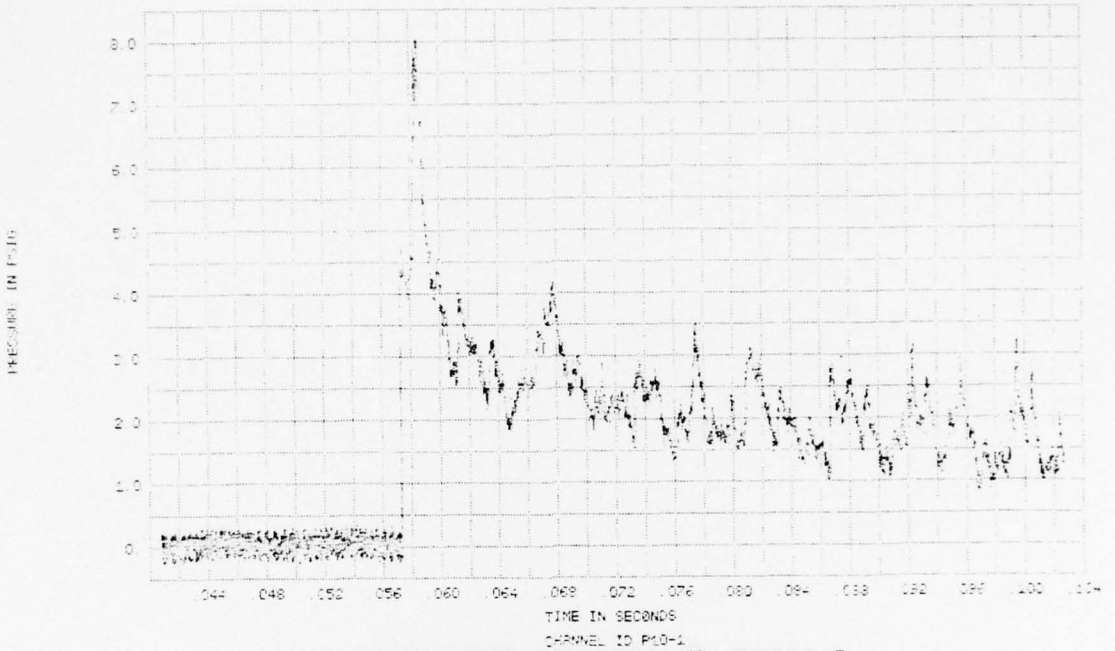


FIGURE 10-53 , SPECIMEN NO. 10 , SHOT NO. 5 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

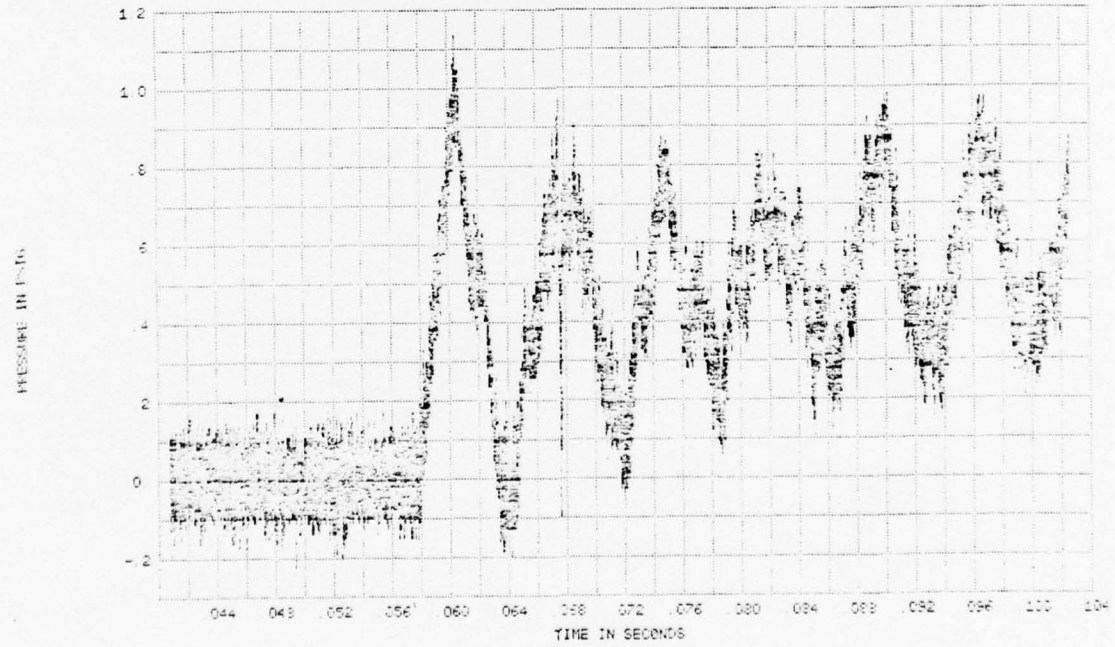


FIGURE 10-54 , SPECIMEN NO. 10 , SHOT NO. 5 ,
INTERNAL PRESSURE TIME HISTORY

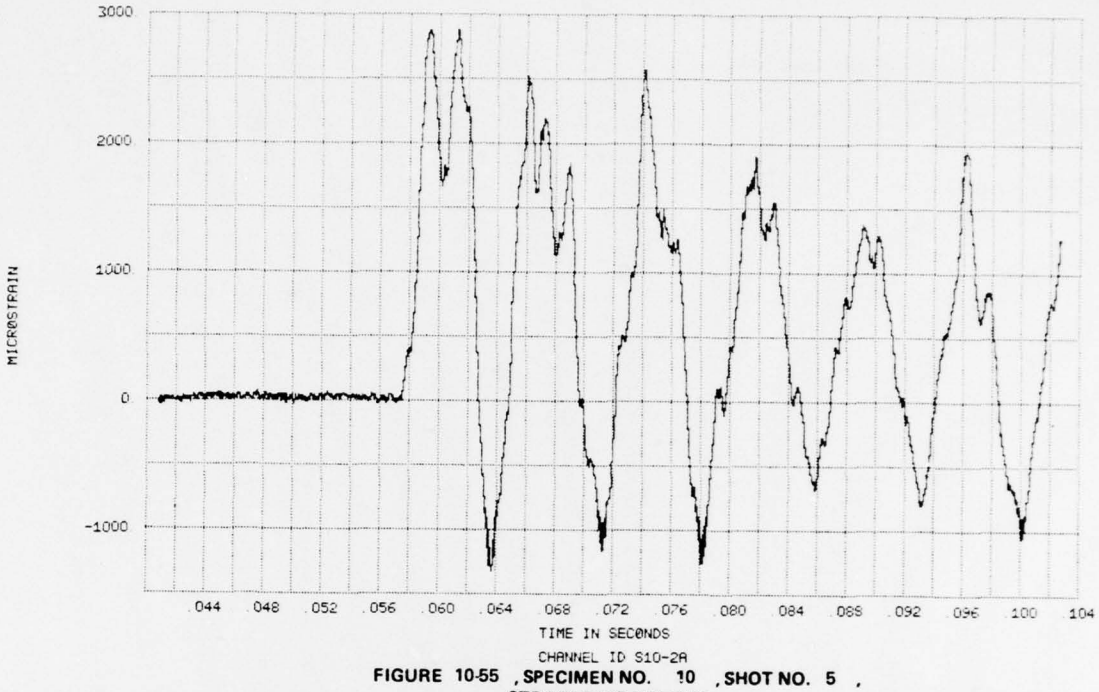


FIGURE 10-55 , SPECIMEN NO. 10 , SHOT NO. 5 ,
STRAIN TIME HISTORY

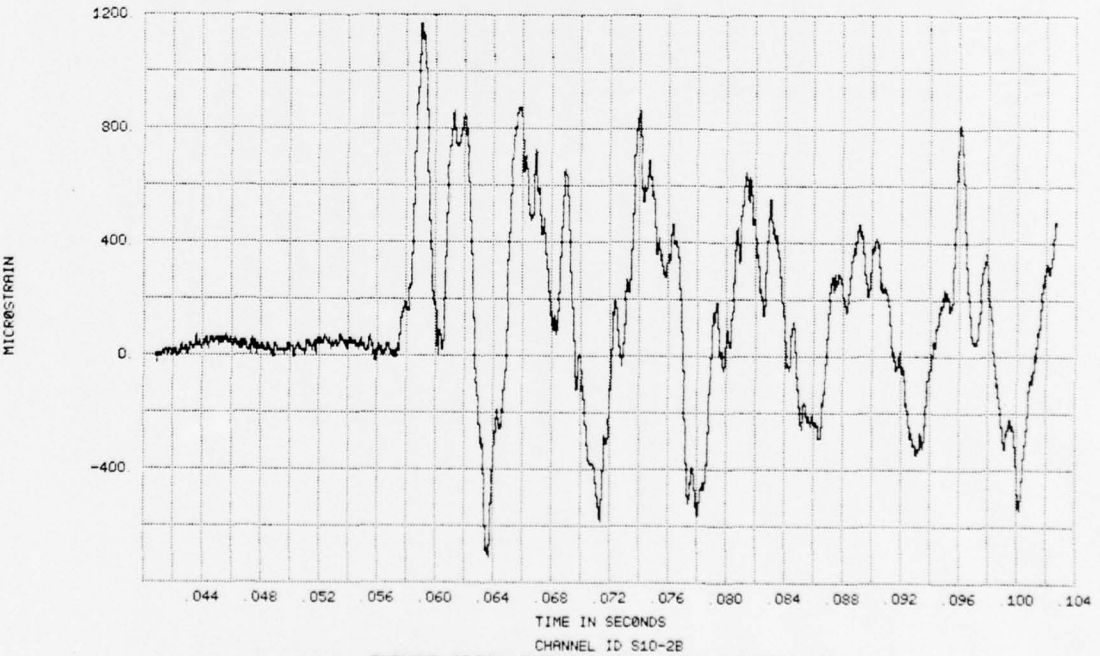


FIGURE 10-56 , SPECIMEN NO. 10 , SHOT NO. 5 ,
STRAIN TIME HISTORY

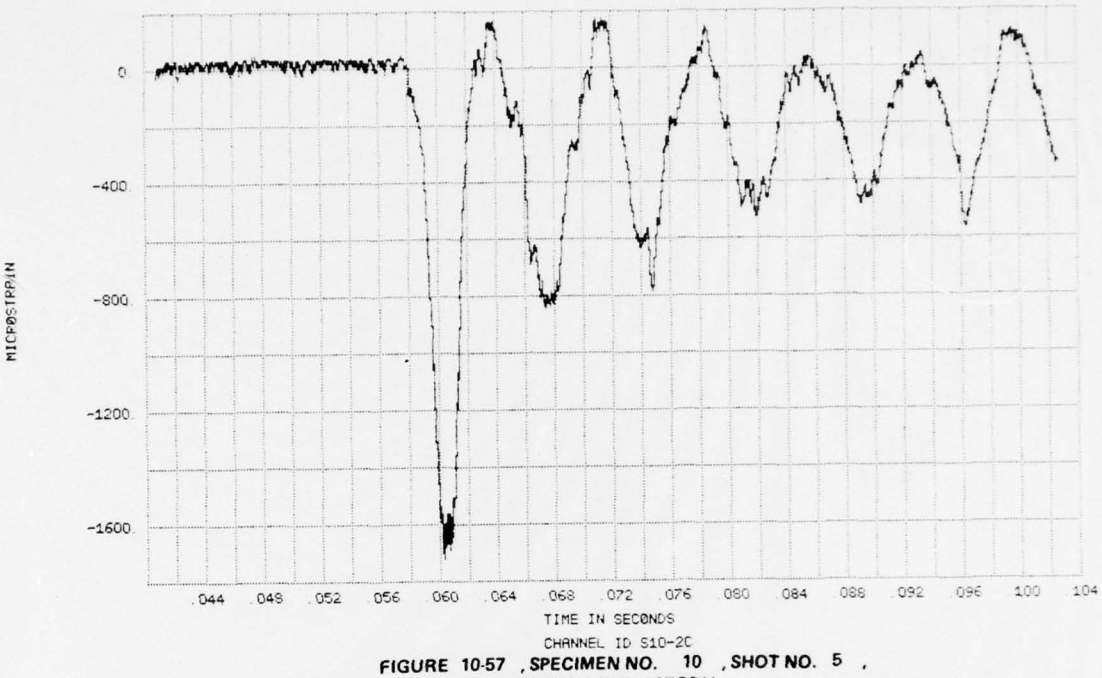


FIGURE 10-57 , SPECIMEN NO. 10 , SHOT NO. 5 ,
STRAIN TIME HISTORY

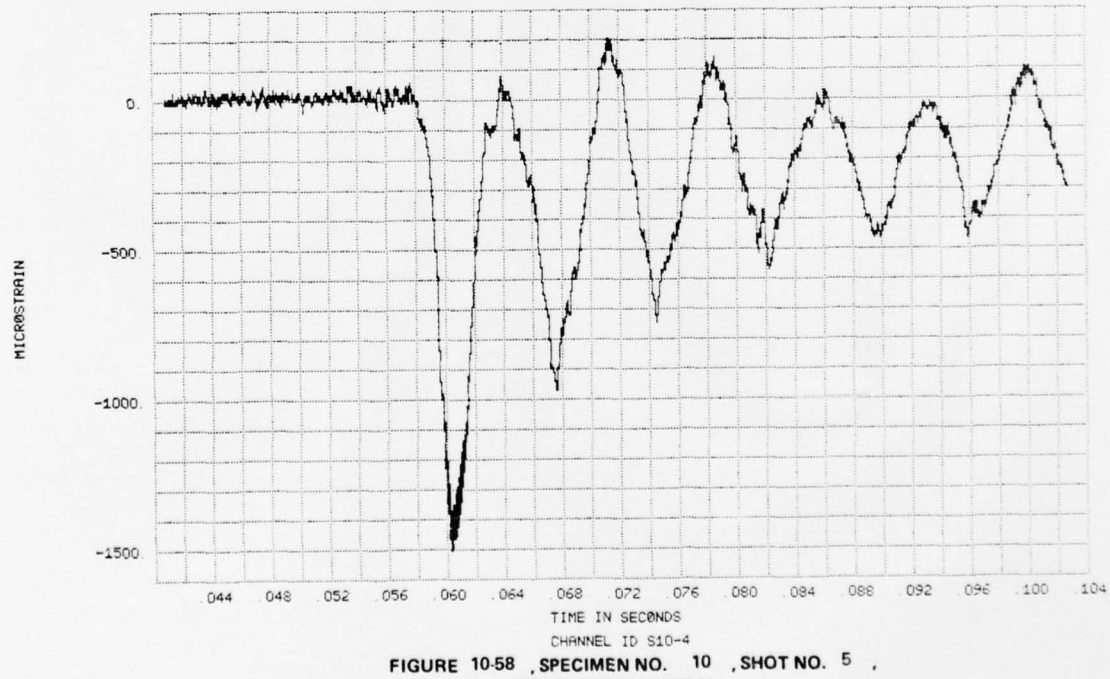


FIGURE 10-58 , SPECIMEN NO. 10 , SHOT NO. 5 ,
STRAIN TIME HISTORY

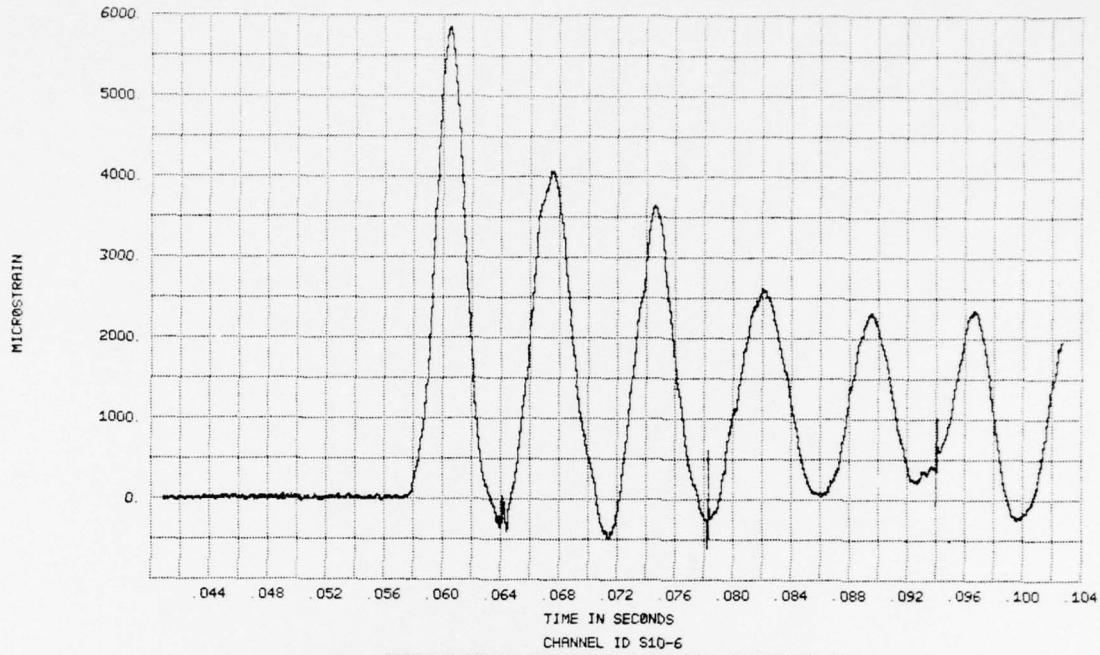


FIGURE 10-59 SPECIMEN NO. 10 , SHOT NO. 5 , STRAIN TIME HISTORY

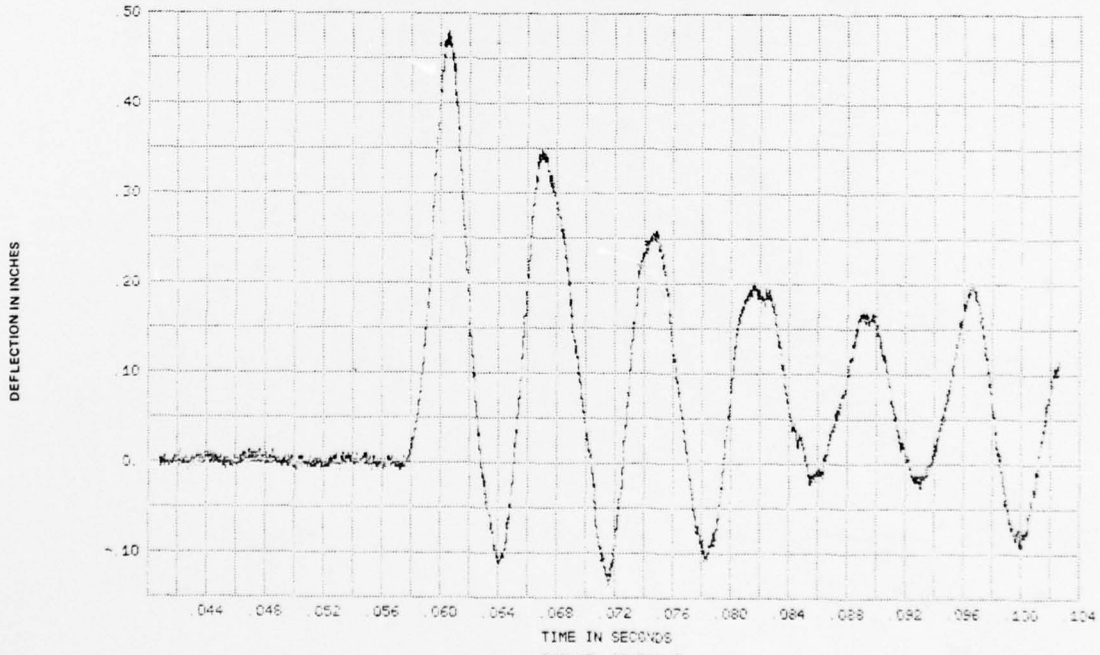


FIGURE 10-60 , SPECIMEN NO. 10 , SHOT NO. 5 , DEFLECTION TIME HISTORY

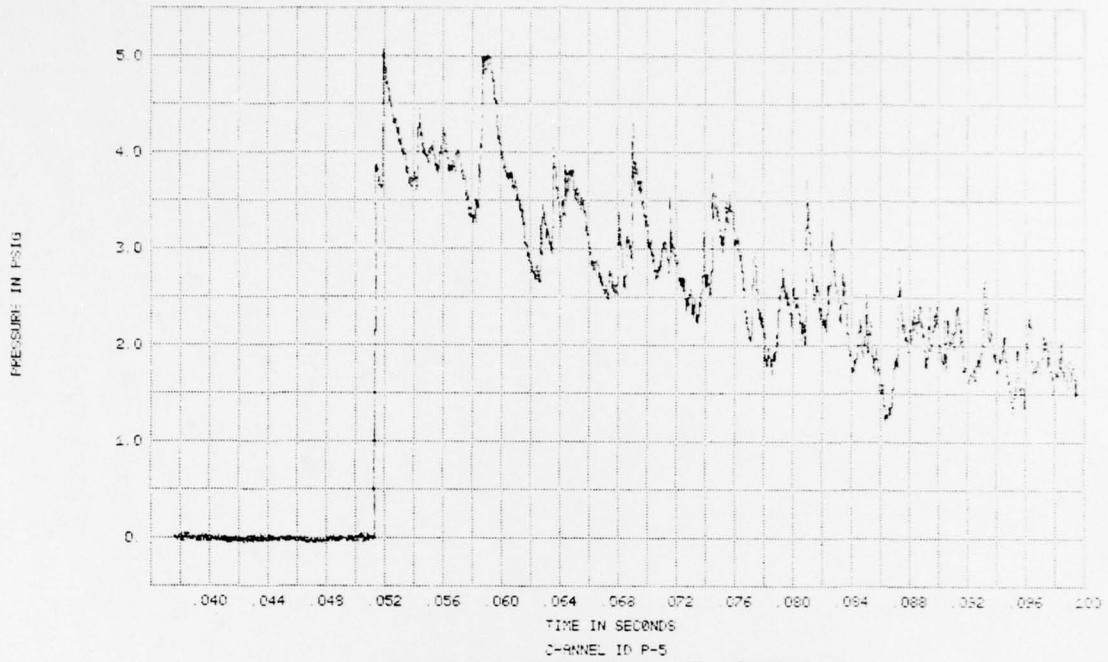


FIGURE 10-61 , SPECIMEN NO. 10 , SHOT NO. 6 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

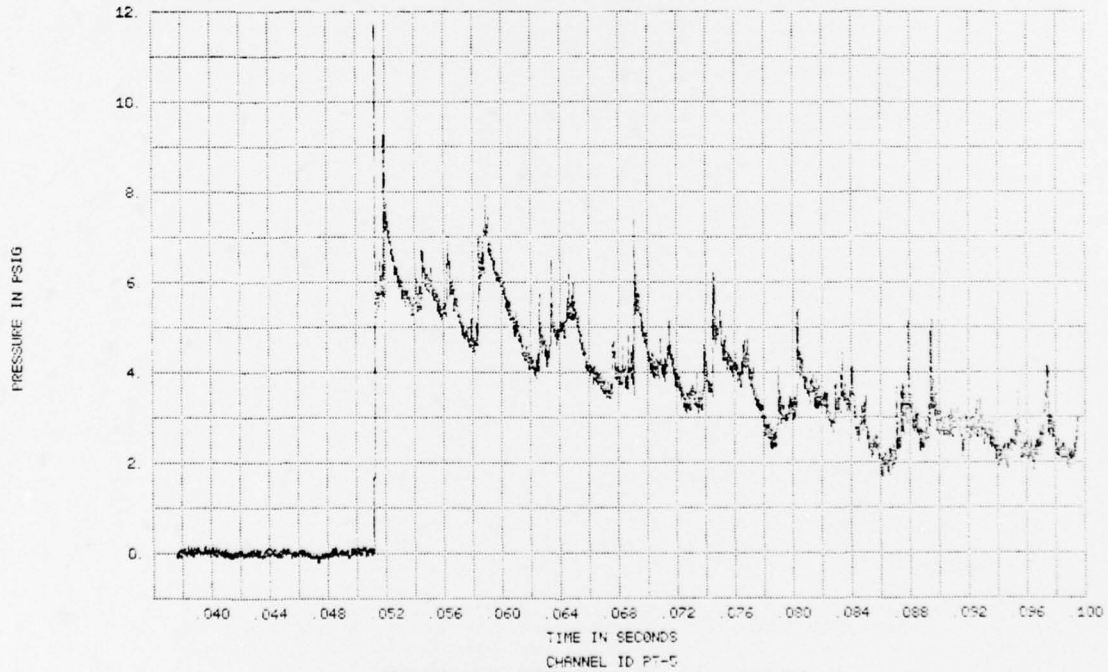


FIGURE 10-62 , SPECIMEN NO. 10 , SHOT NO. 6 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

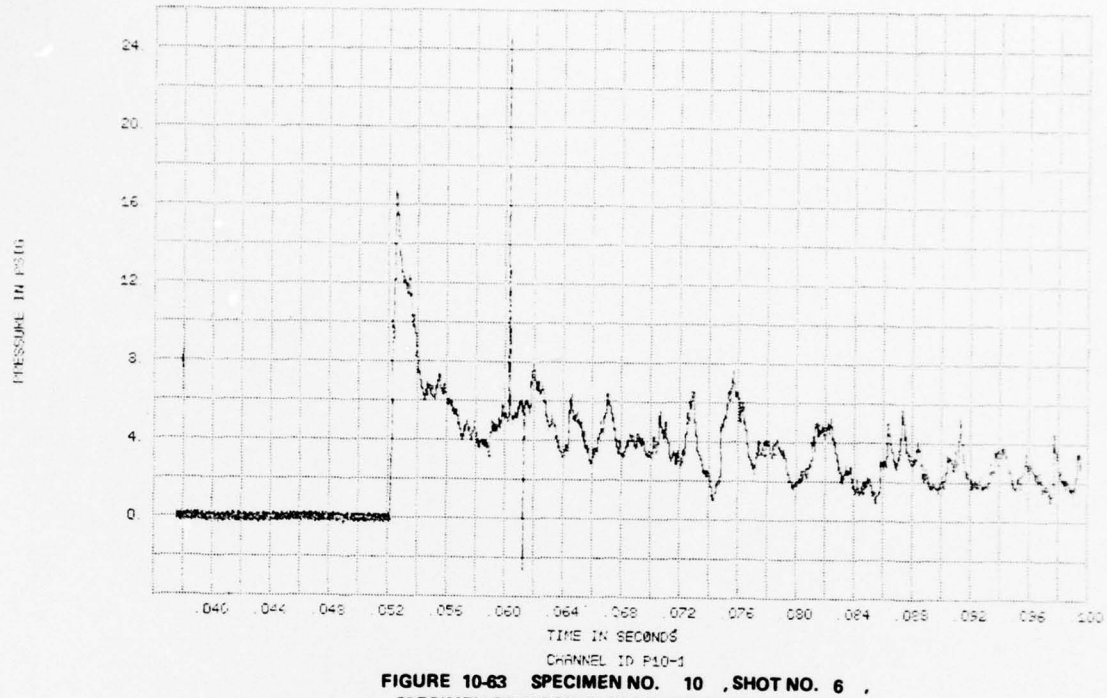


FIGURE 10-63 SPECIMEN NO. 10 , SHOT NO. 6 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

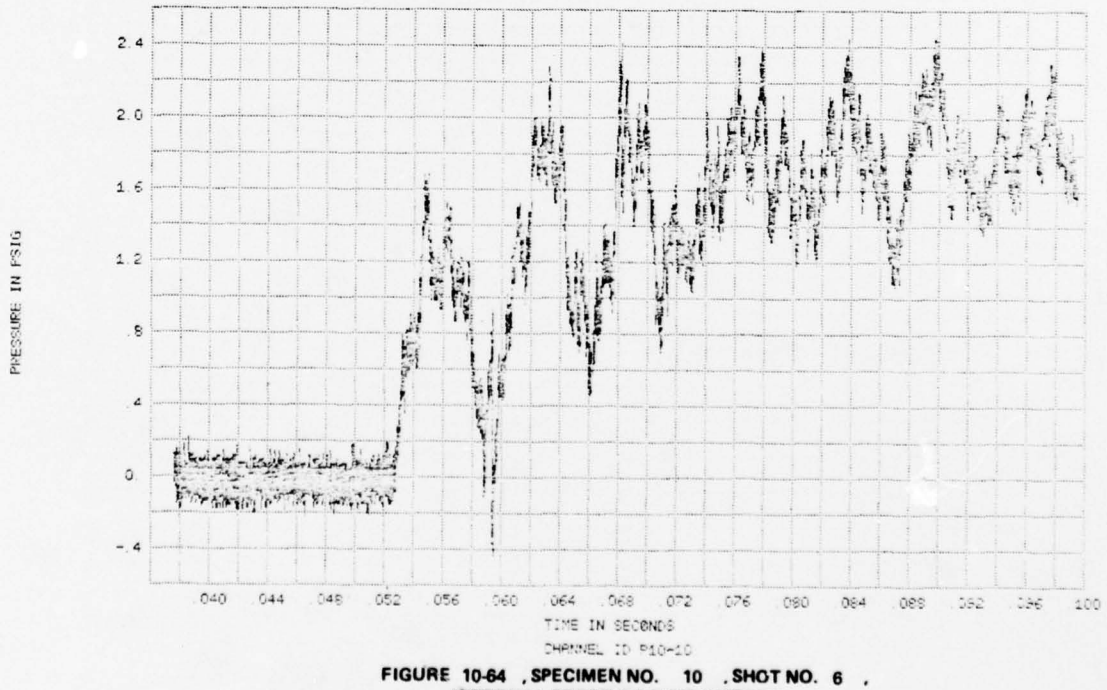


FIGURE 10-64 , SPECIMEN NO. 10 , SHOT NO. 6 ,
INTERNAL PRESSURE TIME HISTORY

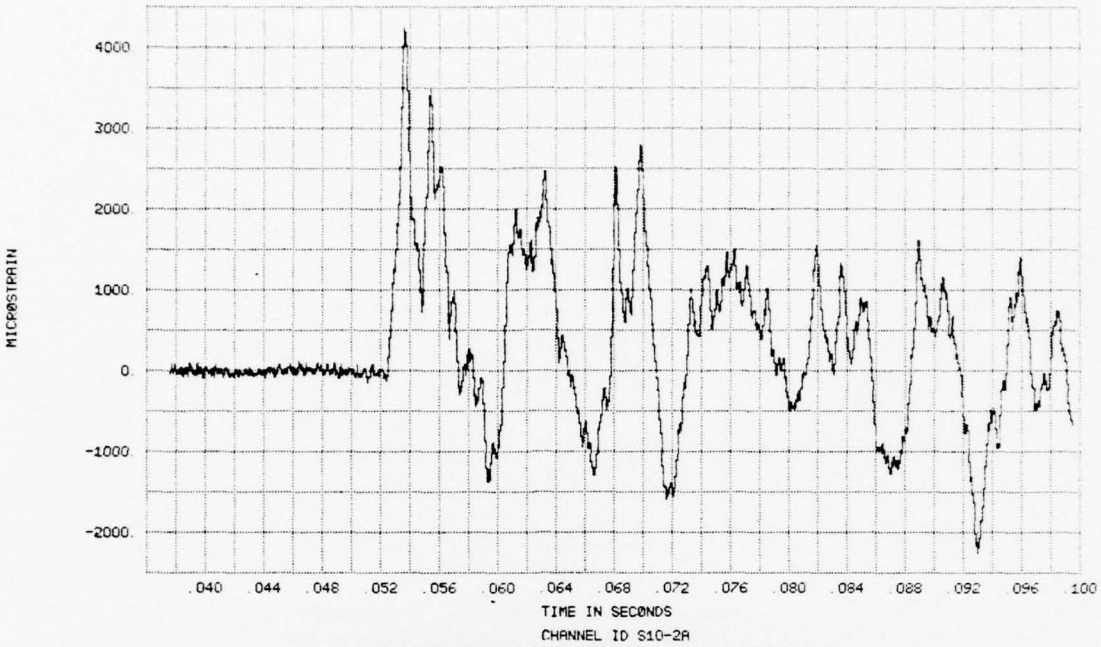


FIGURE 10-65 , SPECIMEN NO. 10 , SHOT NO. 6 ,
STRAIN TIME HISTORY

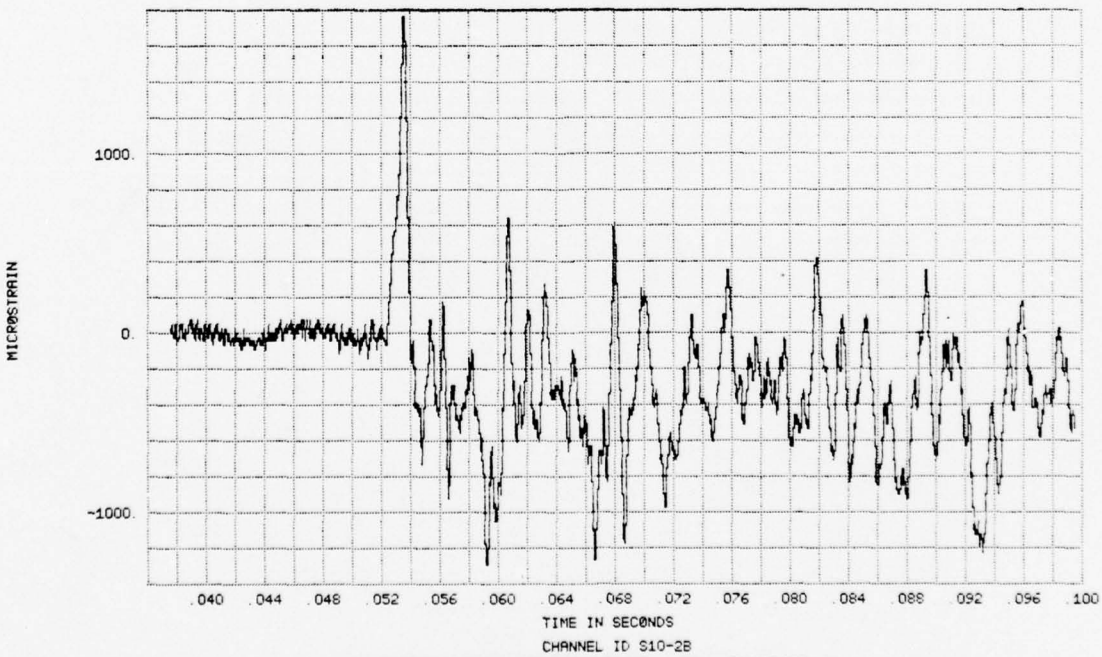


FIGURE 10-66 , SPECIMEN NO. 10 , SHOT NO. 6 ,
STRAIN TIME HISTORY

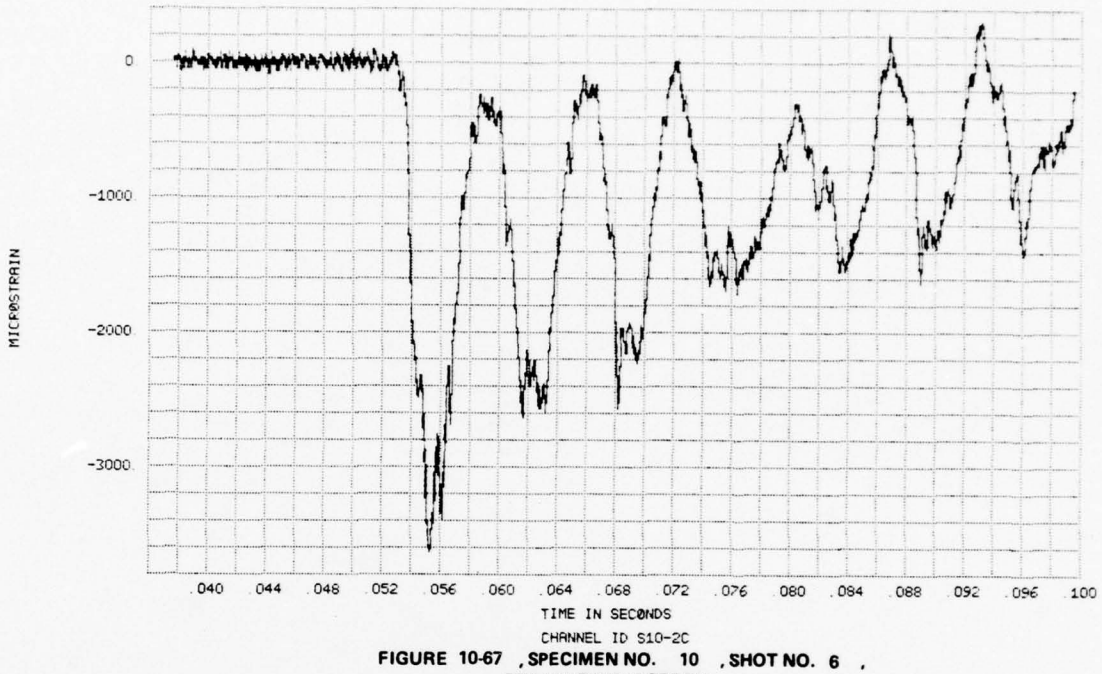


FIGURE 10-67 , SPECIMEN NO. 10 , SHOT NO. 6 ,
STRAIN TIME HISTORY

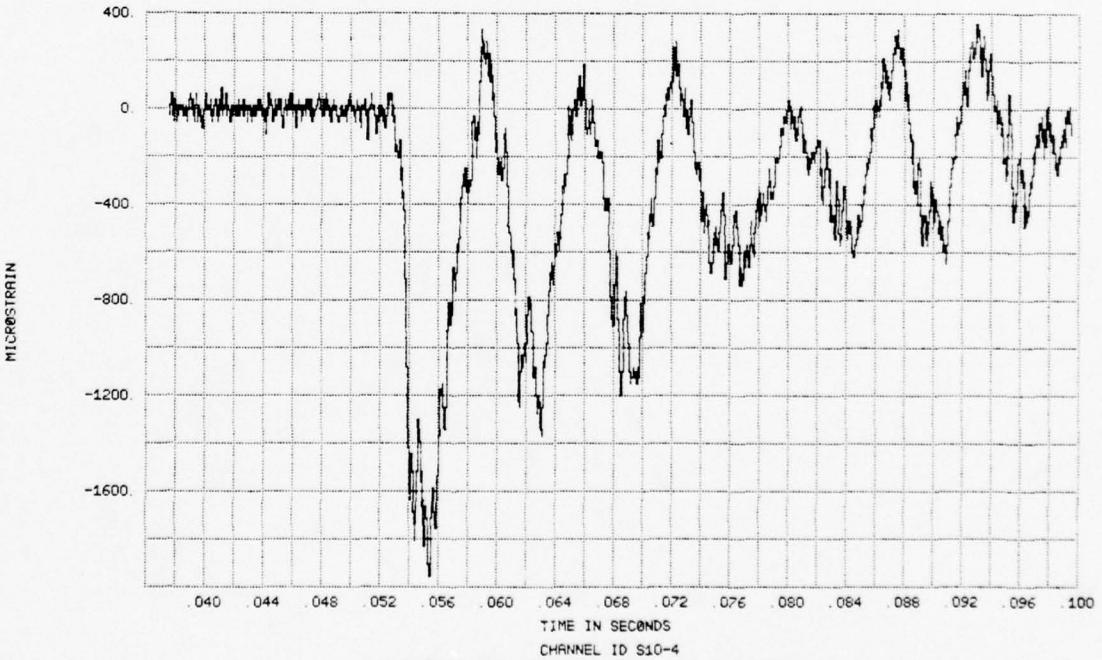
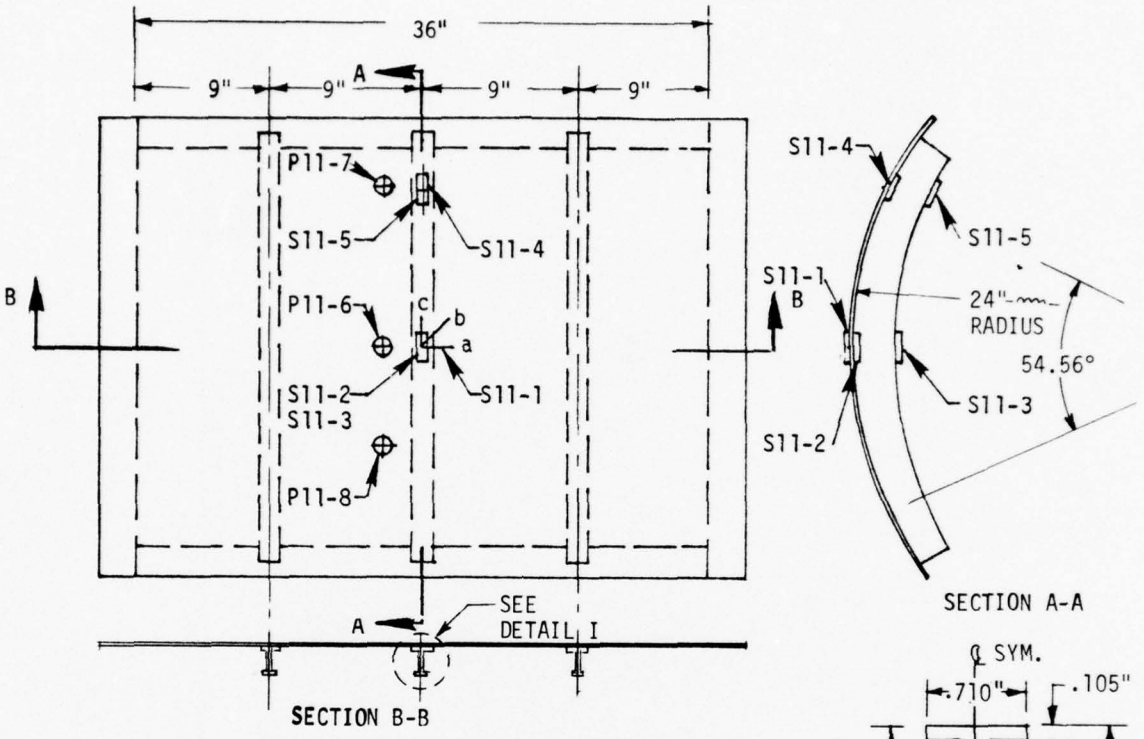
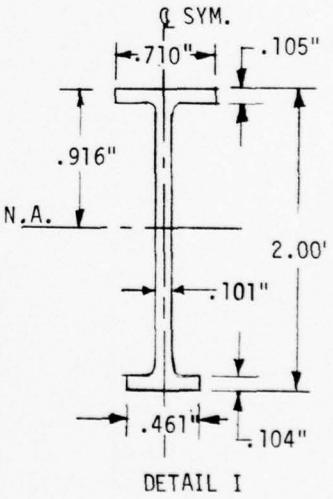


FIGURE 10-68 , SPECIMEN NO. 10 , SHOT NO. 6 ,
STRAIN TIME HISTORY





SPECIMEN NO. 11

CURVED STIFFENED PANEL

STIFFENERS CLAMPED AT ENDS

MATERIAL - 6061-T42 ALUMINUM ALLOY

DENSITY - .0002539 lb-sec^2/in^4 (MIL-HDBK-5)

POISSON'S RATIO - .33

MODULUS OF ELASTICITY - 10.5 x 10^6 PSI

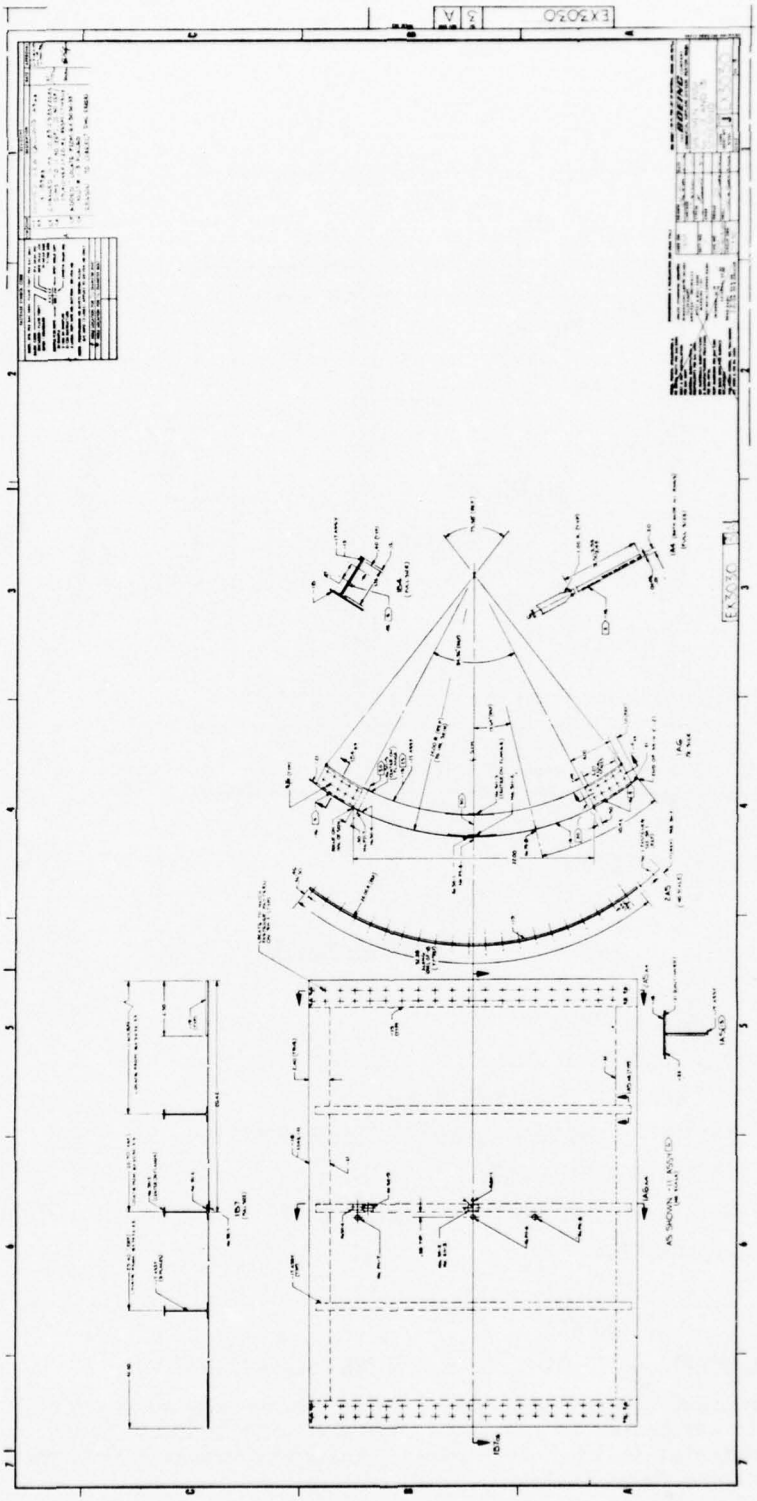
% ELONGATION - 27.0

F_{ty} - 19,670 PSI

F_{tu} - 36,600 PSI

STRESS/STRAIN DATA BASED ON COUPON TEST AND MIL-HDBK-5

The skin was not included in the cross section due to the fact that it was bonded to the frame, and the shear modulus of the bond material is low. As a result, the shear transfer from the skin to the frame is low.



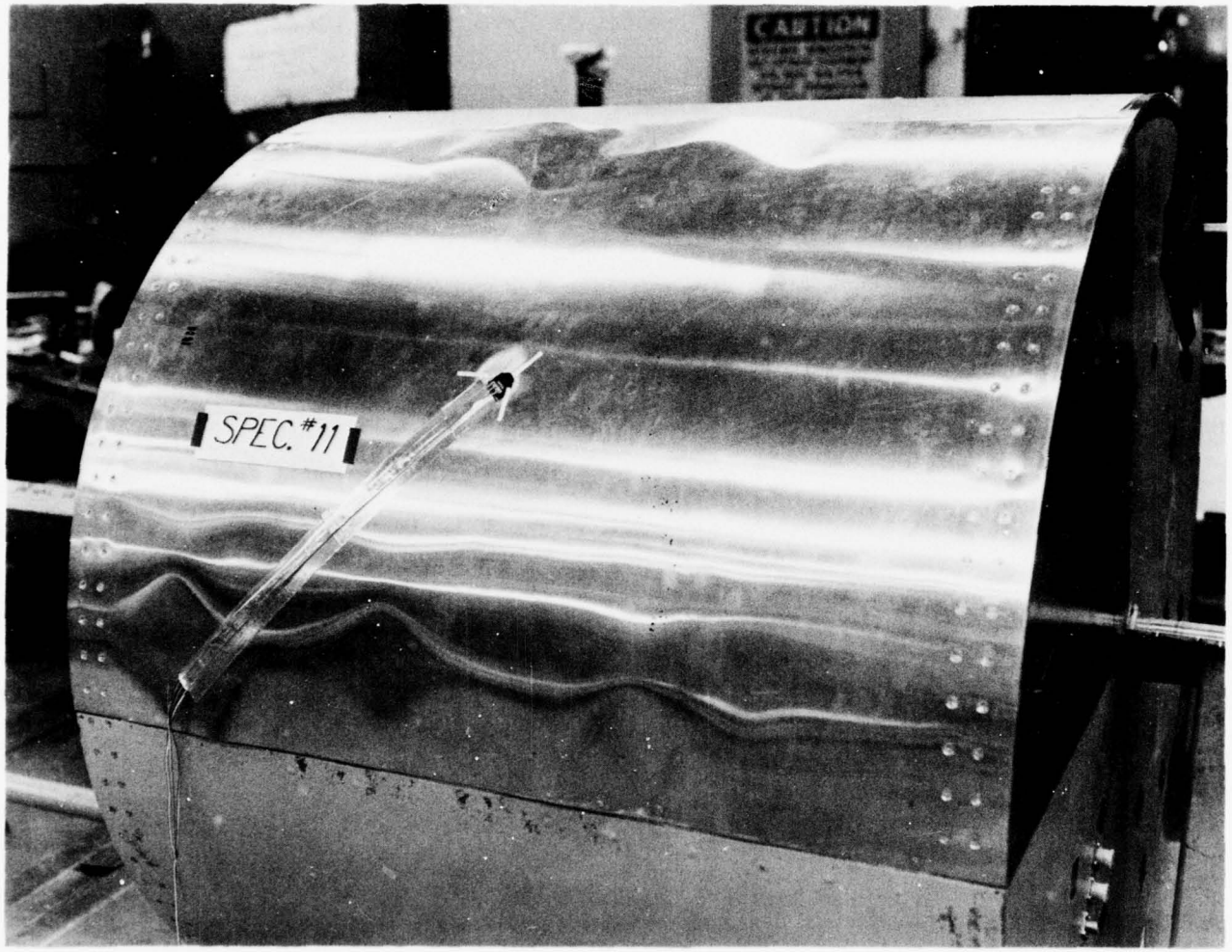


FIGURE 11-1 - SPECIMEN NO. 11 - TEST SET-UP

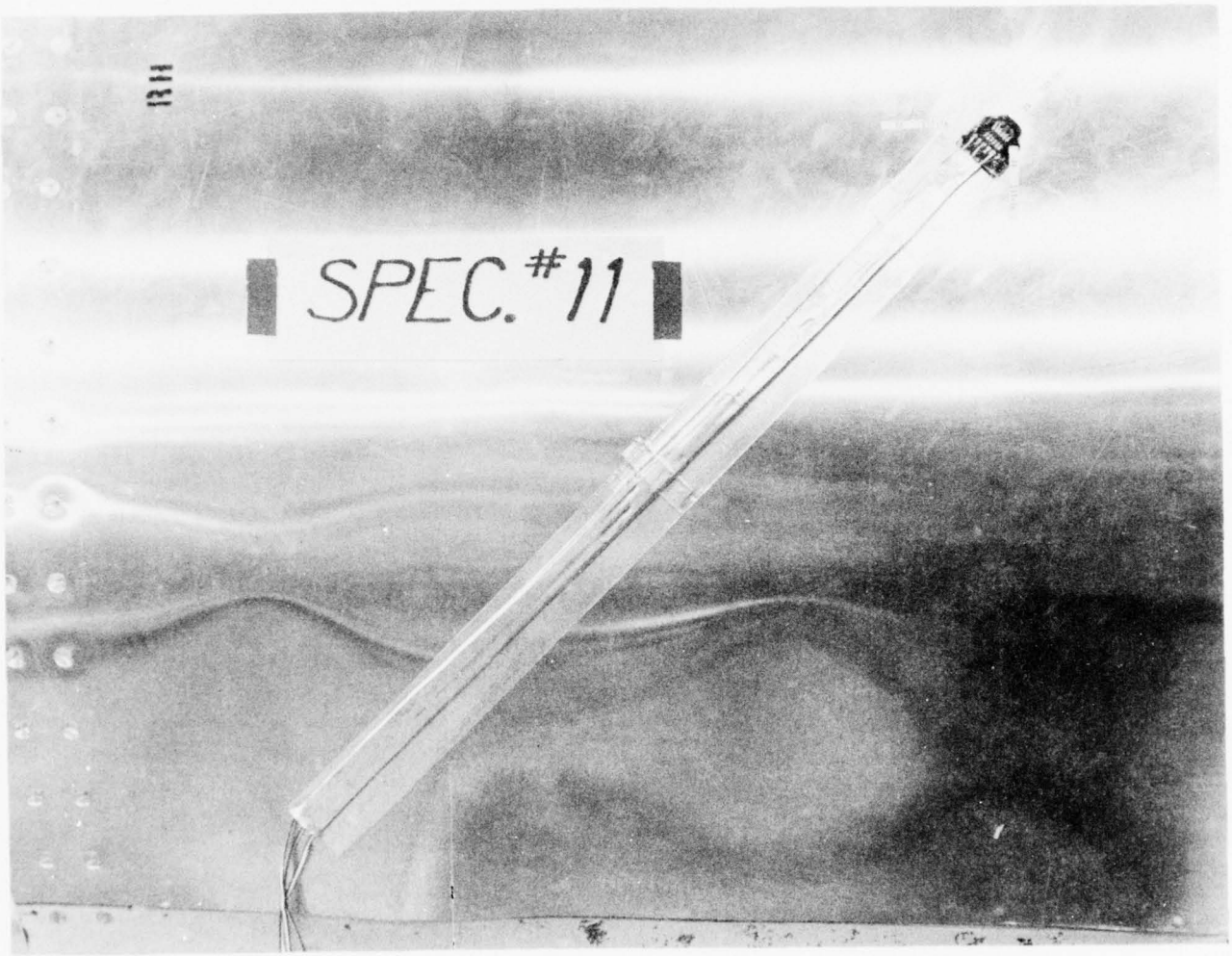


FIGURE 11-2 - SPECIMEN NO. 11 - INSTRUMENTATION - OUTSIDE

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.11 - STATIC ANALYSIS - PRESS = 4.0 PSI - MAY'76 - SYRING  GP   1
          1              0                                                 GP   2
0.0        0.1            0.01          0.0                               GP   3
0.0        0.0            0.0           0.0                               GP   4
         15             15                                                 GP   5
100000.                                                                    GP   7
                                                                           GP   8
          2              0                                                 GP   9
          2                                                                GP  10
          0              0                                                 GP  12
          0              0                                                 GP  15
          0              0                                                 GP  18
          3                                                                GP  21
0.0       -36.0                                                            GP  22
0.0        0.0                                                             GP  23
0.0       24.0                                                             GP  24
-18.0     24.0                                                             GP  24
-36.0     24.0                                                             GP  24
          2              7                                                 GP  25
          2                                                                GP  27
0.0                                                                        GP  29
-4.0                                                                       GP  30
          1              2             2           1           1          GPB   1
         20              3             4                                  GPB   2
23.0                                                                       GPB   3
1.095      2.047                                                           GPB   4
          0                                                                GPB   8
          1              1             1                                  GPB  12
.0002539   .0002539       .0002539                                        GPB  13
9.0                                                                        GPB  14
0.104                                                                      GPB  15
0.710                                                                      GPB  16
          2                                                                GPB  17
.00187     19670.                                                          GPB  18
.0029      20000.                                                          GPB  18
          2                                                                GPB  19
.00187     19670.                                                          GPB  20
.0029      20000.                                                          GPB  20
1.791                                                                      GPB  15
0.101                                                                      GPB  16
          2                                                                GPB  17
.00187     19670.                                                          GPB  18
.0029      20000.                                                          GPB  18
          2                                                                GPB  19
.00187     19670.                                                          GPB  20
.0029      20000.                                                          GPB  20
0.105                                                                      GPB  15
0.461                                                                      GPB  16
          2                                                                GPB  17
.00187     19670.                                                          GPB  18
.0029      20000.                                                          GPB  18
          2                                                                GPB  19
.00187     19670.                                                          GPB  20
.0029      20000.                                                          GPB  20
.000001    .000001      1.0                                                GPB  22
                                                                           GP  32
```

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TABLE XL

STATIC TEST STRESSES - SPECIMEN NO. 11
(STRESSES GIVEN IN PSI)

STRAIN GAUGE	STATIC PRESSURE (PSI)								
	1.2	2.4	3.5	4.5	5.5	6.0	6.5	7.0	7.5
S11-1	4642.	11020.	15190.	18437.	22354.	26351.	28776.	30971.	36483.
S11-2	-651.	-1796.	-3150.	-4316.	-5450.	-5943.	-6552.	-7109.	-7382.
S11-3	-431.	-546.	-714.	-830.	-924.	-956.	-966.	-1019.	-1050.
S11-4	-242.	63.	473.	378.	221.	168.	168.	-32.	-546.
S11-5	-882.	-2132.	-3297.	-4326.	-5345.	-5838.	-6353.	-6794.	-7109.

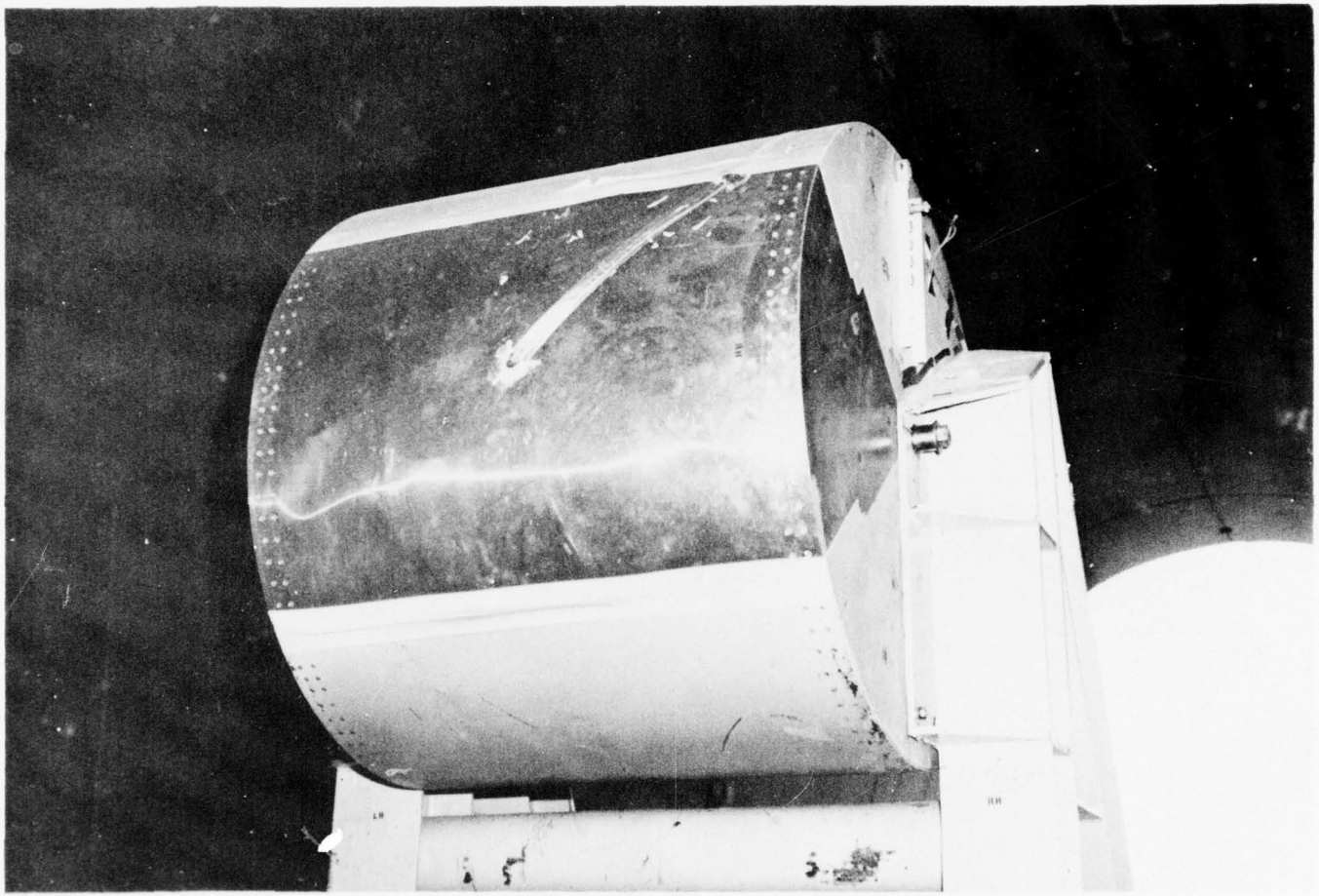


FIGURE 11-3 - SPECIMEN NO. 11 - SHOCK TEST SET-UP (FROM RIGHT SIDE)

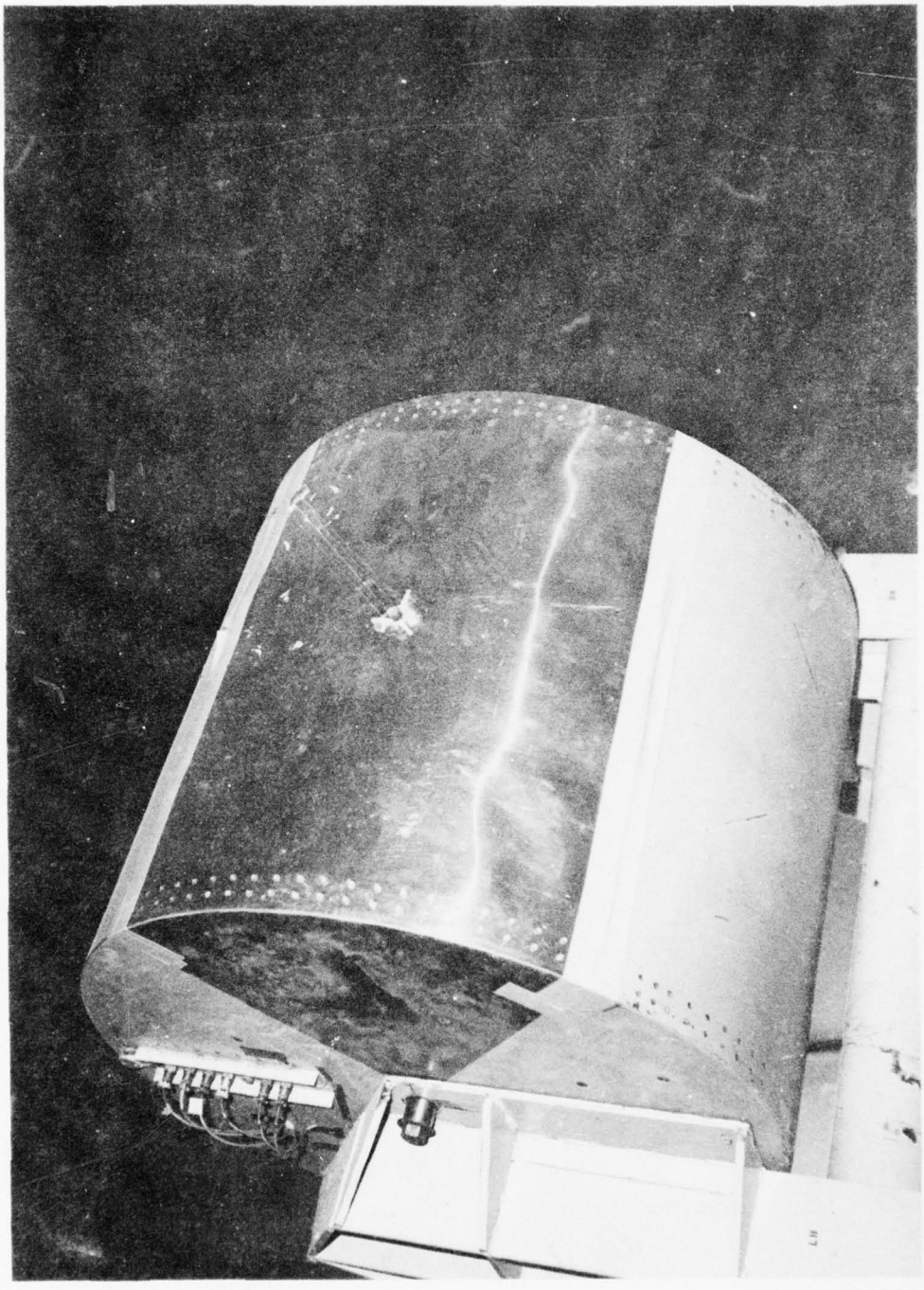


FIGURE 11-4 - SPECIMEN NO. 11 - SHOCK TEST SET-UP (FROM LEFT SIDE)

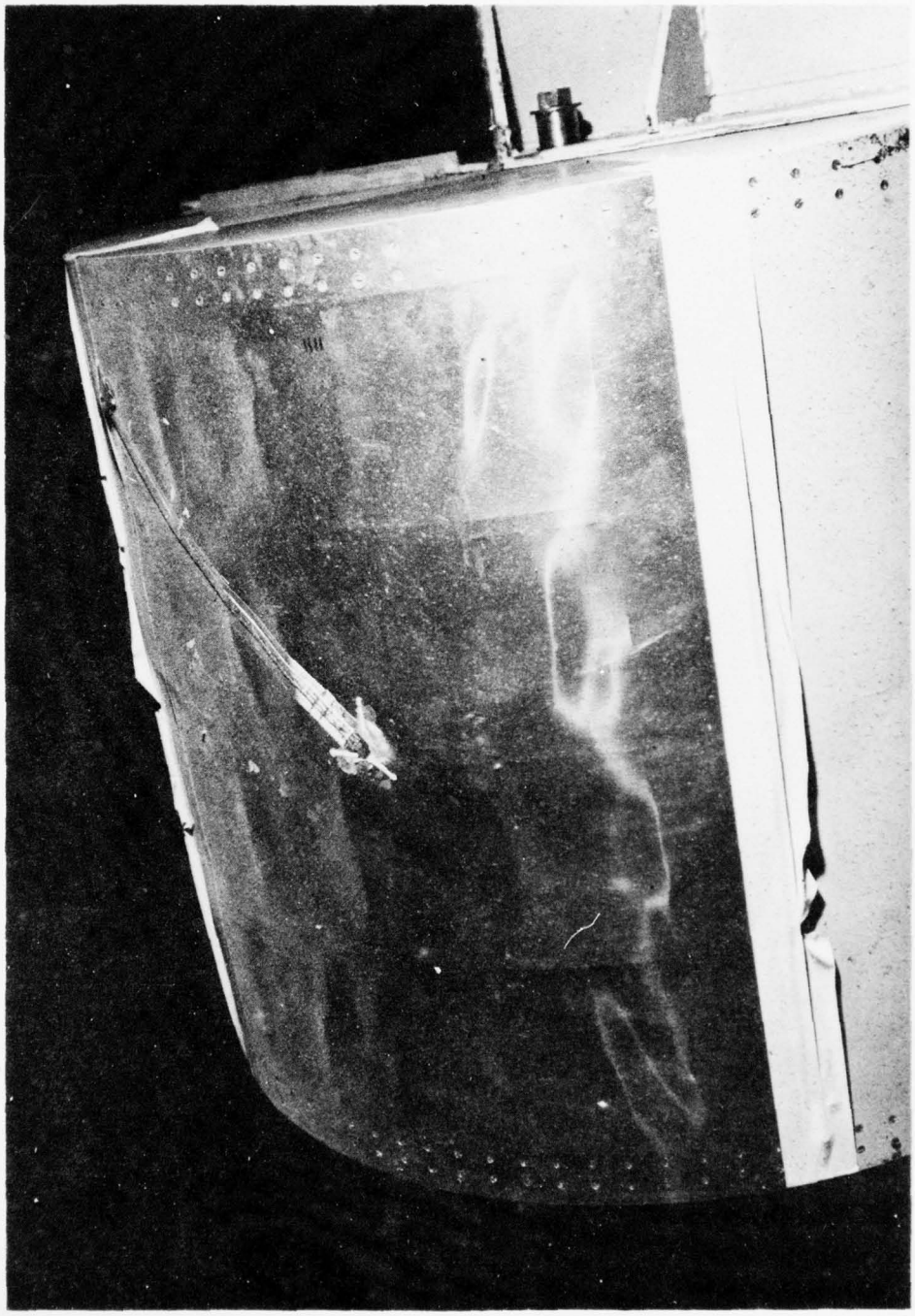


FIGURE 11-5 - SPECIMEN NO. 11 - SPECIMEN AFTER SHOCK TEST SHOWING SKIN WRINKLES

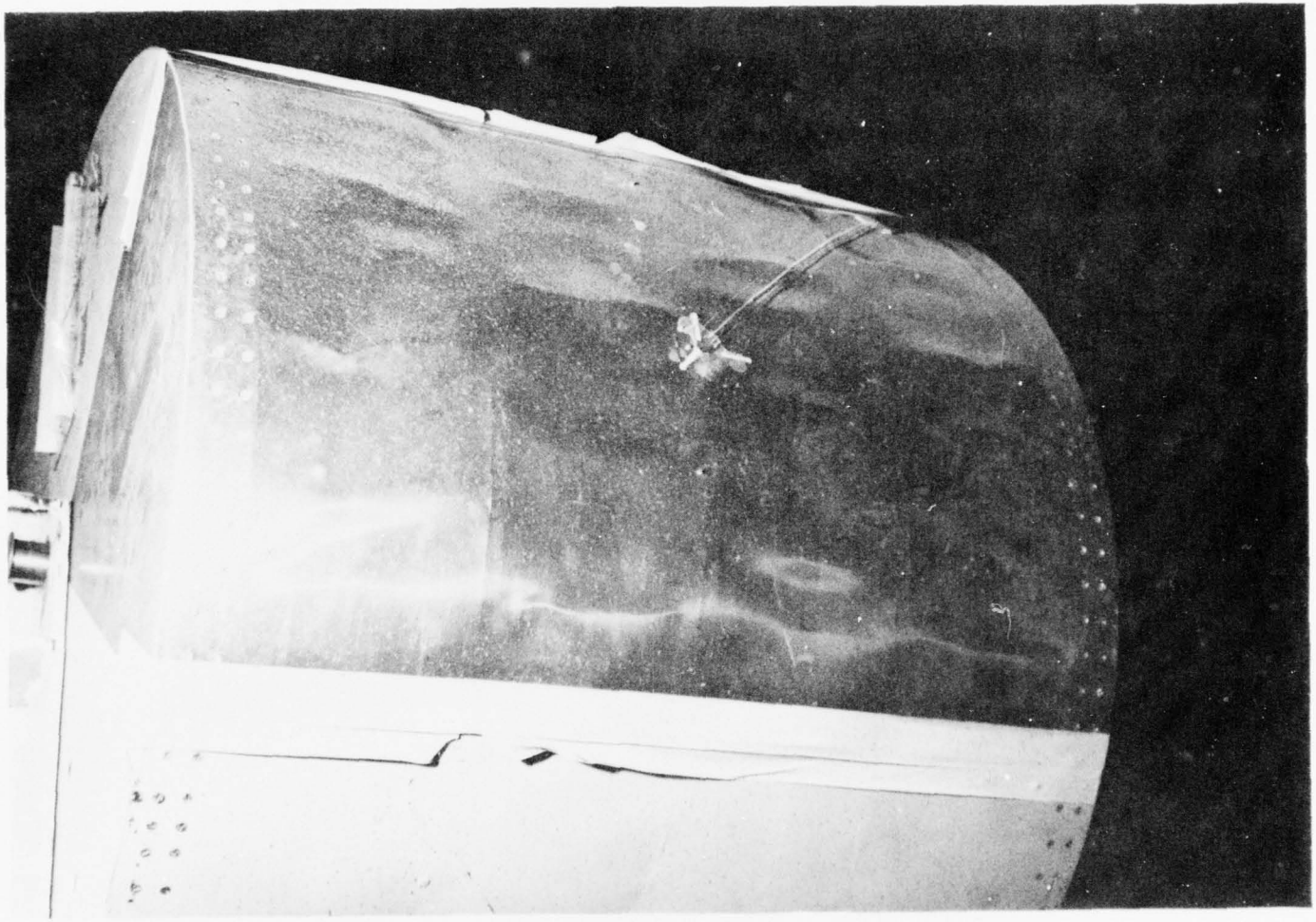


FIGURE 11-6 - SPECIMEN NO. 11 - SPECIMEN AFTER SHOCK TEST SHOWING SKIN WRINKLES



FIGURE 11-7 - SPECIMEN NO. 11 - SPECIMEN RELEASED FROM HOLDING FIXTURE



FIGURE 11-8 - SPECIMEN NO. 11 - INSIDE OF SPECIMEN - NO VISIBLE DAMAGE

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO. 11 - W/EFFECTIVE SKIN - ITERATIVE TPD SOLUTION                GP  1
          1           0                                                         GP  2
9000.      0.001       0.02        0.0                                          GP  3
0.0        0.0         0.0         0.0                                          GP  4
          15          15                                                        GP  5
350.                                                                            GP  7
                                                                                GP  8
          2           0                                                         GP  9
          0           1                                                         GP 10
0.5                                                                             GP 11
          0           0                                                         GP 12
          0           0                                                         GP 15
          0           0                                                         GP 18
          3                                                                     GP 21
0.0       -36.0                                                                 GP 22
0.0        0.0                                                                  GP 23
0.0        24.0                                                                 GP 24
-18.0      24.0                                                                 GP 24
-36.0      24.0                                                                 GP 24
          2           7                                                         GP 25
          2                                                                     GP 27
0.0                                                                             GP 29
                                                                                GP 30
          1           2           2           1           1           1       GPB  1
         20           4           4                                           GPB  2
23.0                                                                            GPB  3
1.095      2.047                                                                GPB  4
          0                                                                     GPB  6
          1           1           1           1                               GPB 12
.0002539   .0002539    .0002539    .0002539                                    GPB 13
9.0                                                                             GPB 14
0.02                                                                            GPB 15
1.45                                                                            GPB 16
          2                                                                     GPB 17
.00363     38618.                                                               GPB 18
.0062      44000.                                                               GPB 18
          2                                                                     GPB 19
.005       53230.                                                               GPB 20
.007       53500.                                                               GPB 20
0.104                                                                           GPB 15
0.710                                                                           GPB 16
          2                                                                     GPB 17
.00187     19670.                                                               GPB 18
.0029      20000.                                                               GPB 18
          2                                                                     GPB 19
.00187     19670.                                                               GPB 20
.0029      20000.                                                               GPB 20
1.791                                                                           GPB 15
0.101                                                                           GPB 16
          2                                                                     GPB 17
.00187     19670.                                                               GPB 18
.0029      20000.                                                               GPB 18
          2                                                                     GPB 19
.00187     19670.                                                               GPB 20
.0029      20000.                                                               GPB 20
0.105                                                                           GPB 15
0.461                                                                           GPB 16
          2                                                                     GPB 17
.00187     19670.                                                               GPB 18
.0029      20000.                                                               GPB 18
          2                                                                     GPB 19
.00187     19670.                                                               GPB 20
.0029      20000.                                                               GPB 20
0.3     E-050.003       25.0                                                    GPB 22
                                                                                GP  32
```

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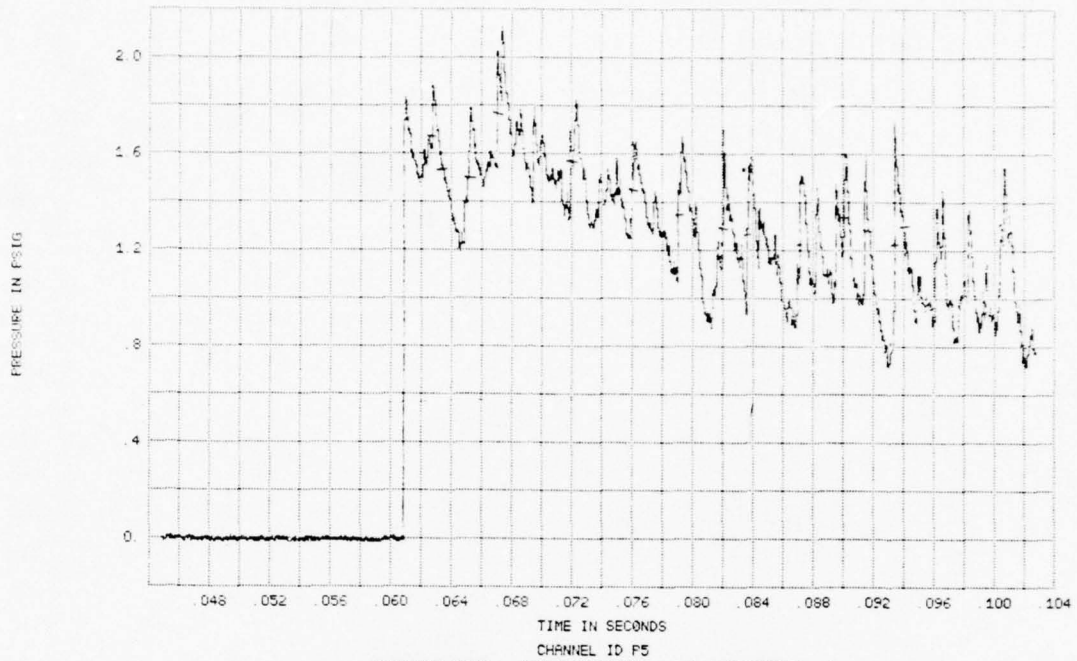


FIGURE 11-9 , SPECIMEN NO. 11 , SHOT NO. 1 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

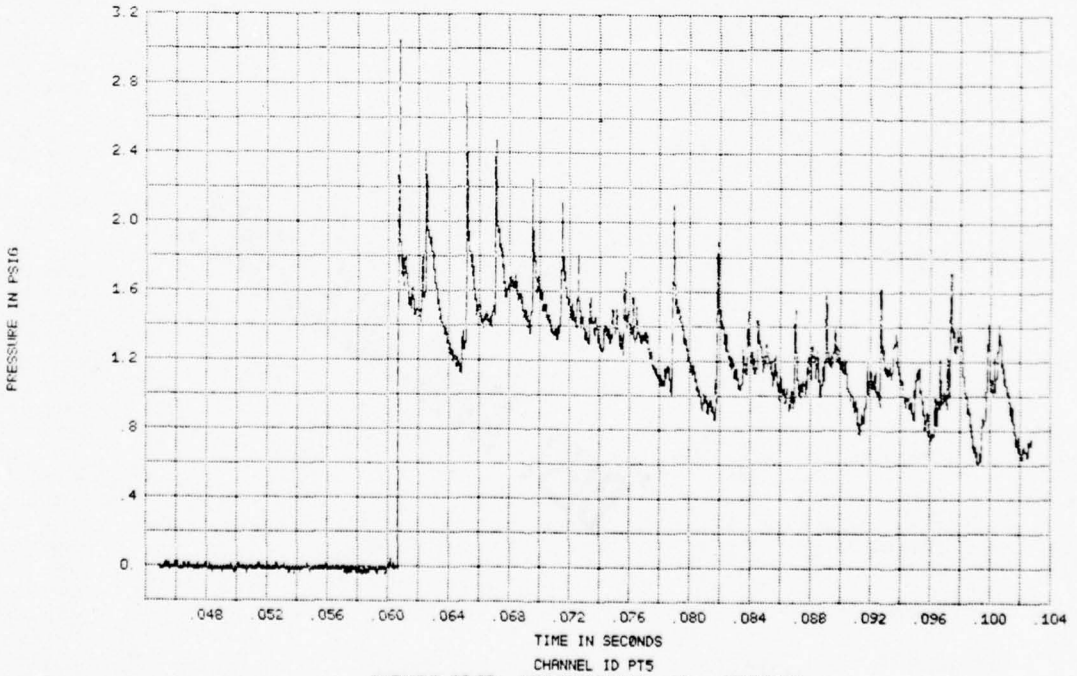


FIGURE 11-10 , SPECIMEN NO. 11 , SHOT NO. 1 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

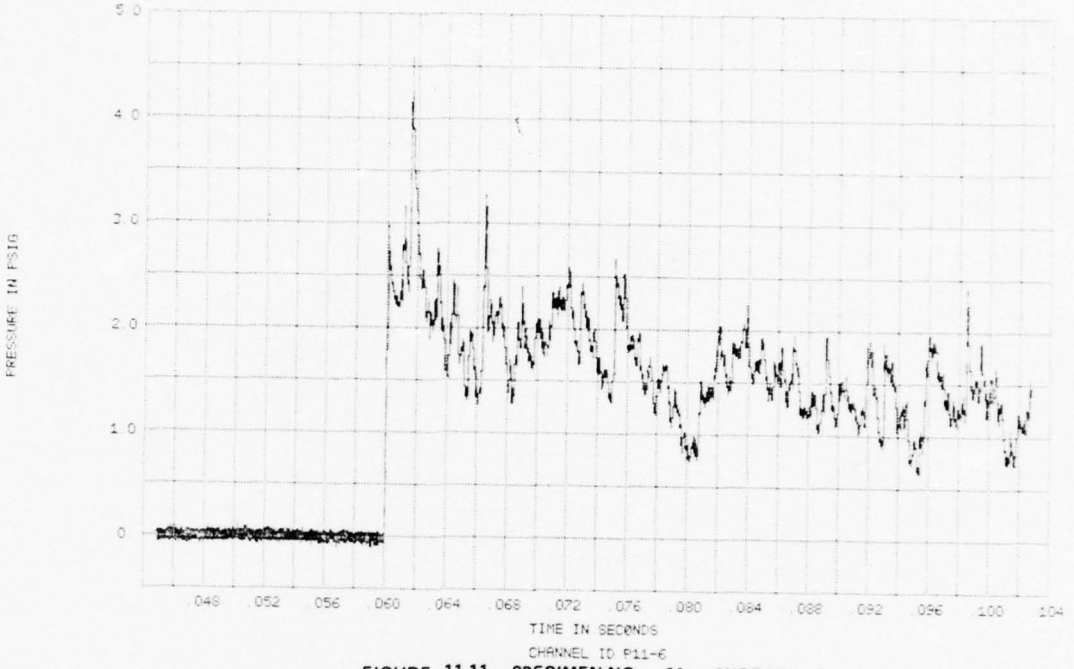


FIGURE 11-11 , SPECIMEN NO. 11 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

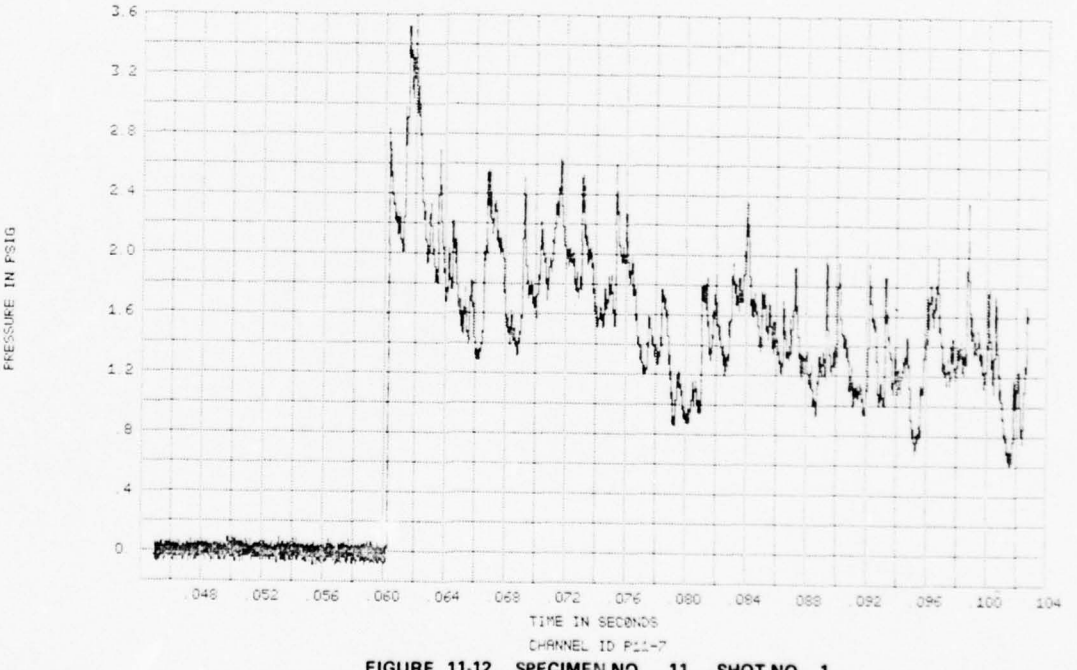


FIGURE 11-12 , SPECIMEN NO. 11 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

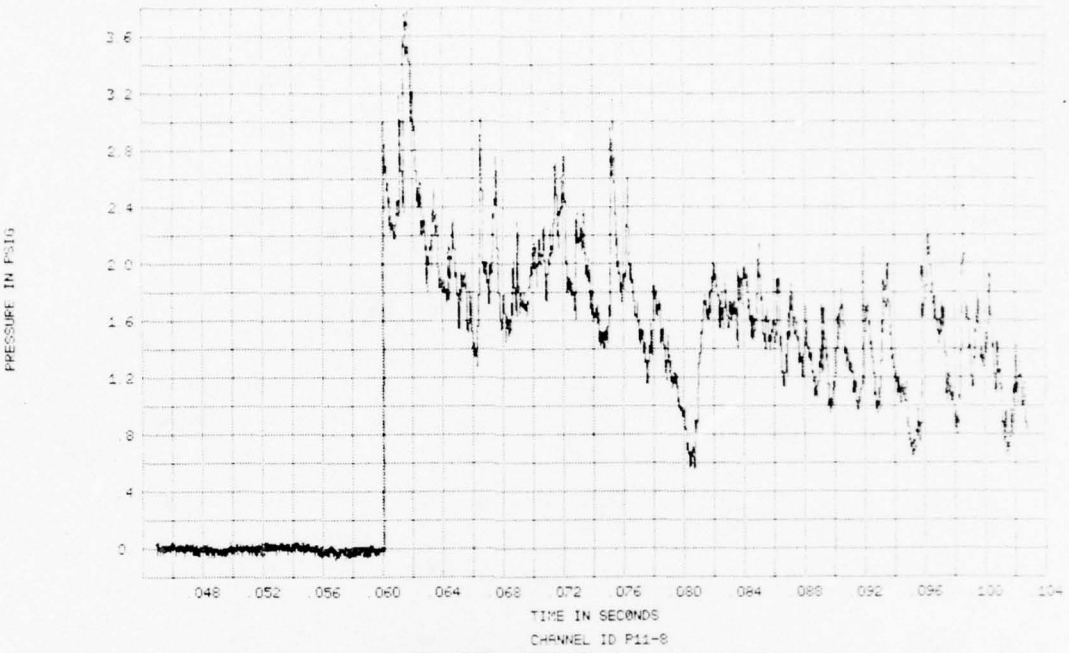


FIGURE 11-13 , SPECIMEN NO. 11 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

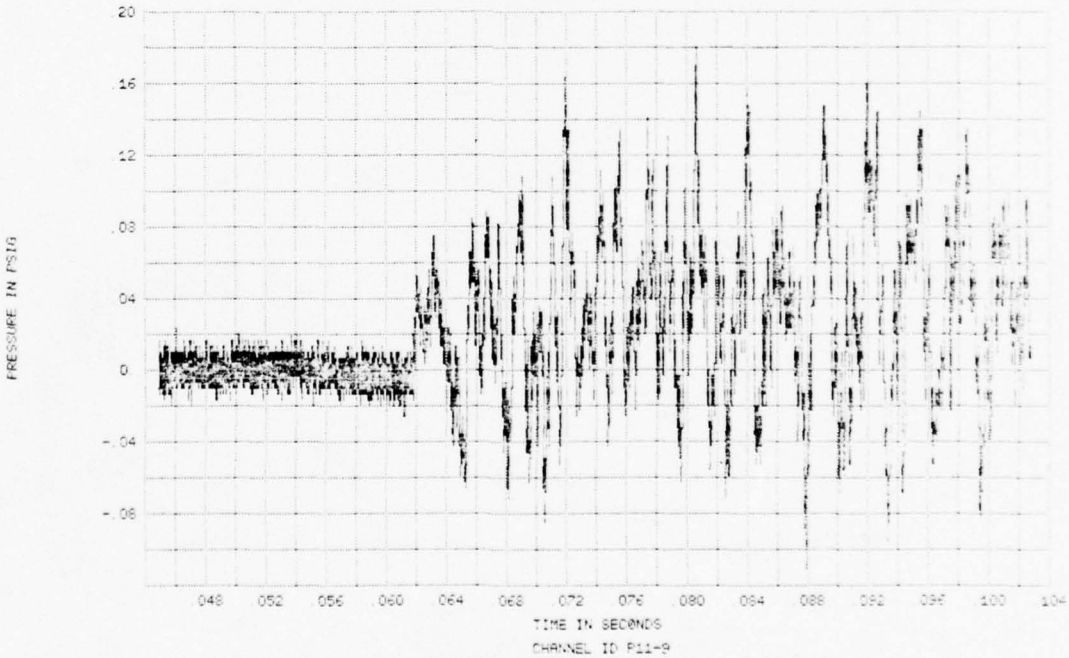


FIGURE 11-14 , SPECIMEN NO. 11 , SHOT NO. 1 ,
INTERNAL PRESSURE TIME HISTORY

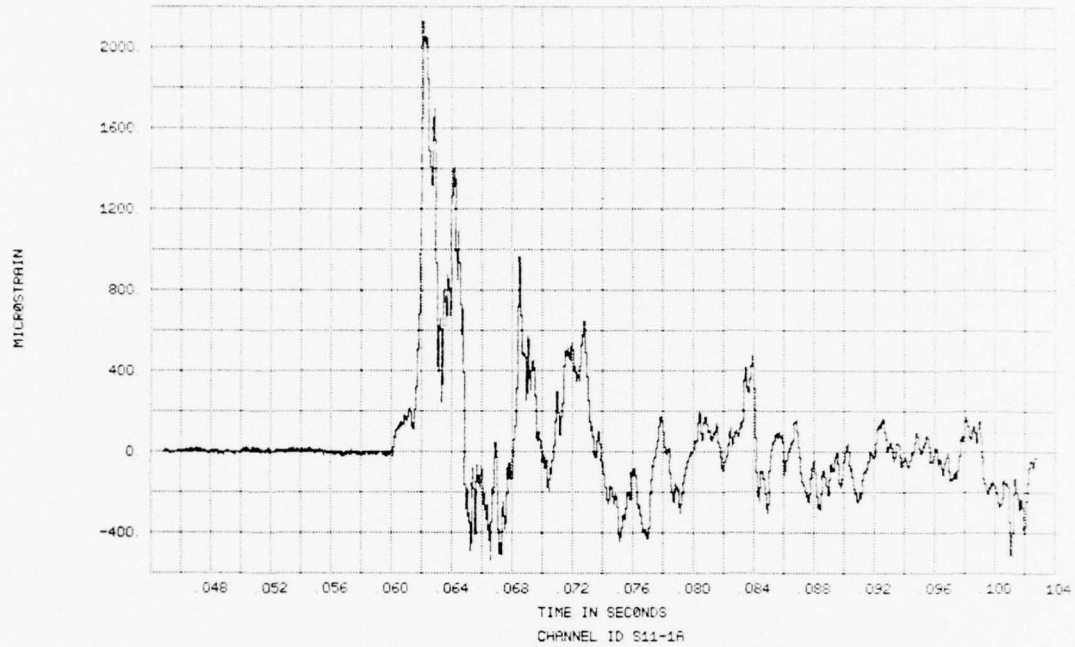


FIGURE 11-15 , SPECIMEN NO. 11 , SHOT NO. 1 ,
STRAIN TIME HISTORY

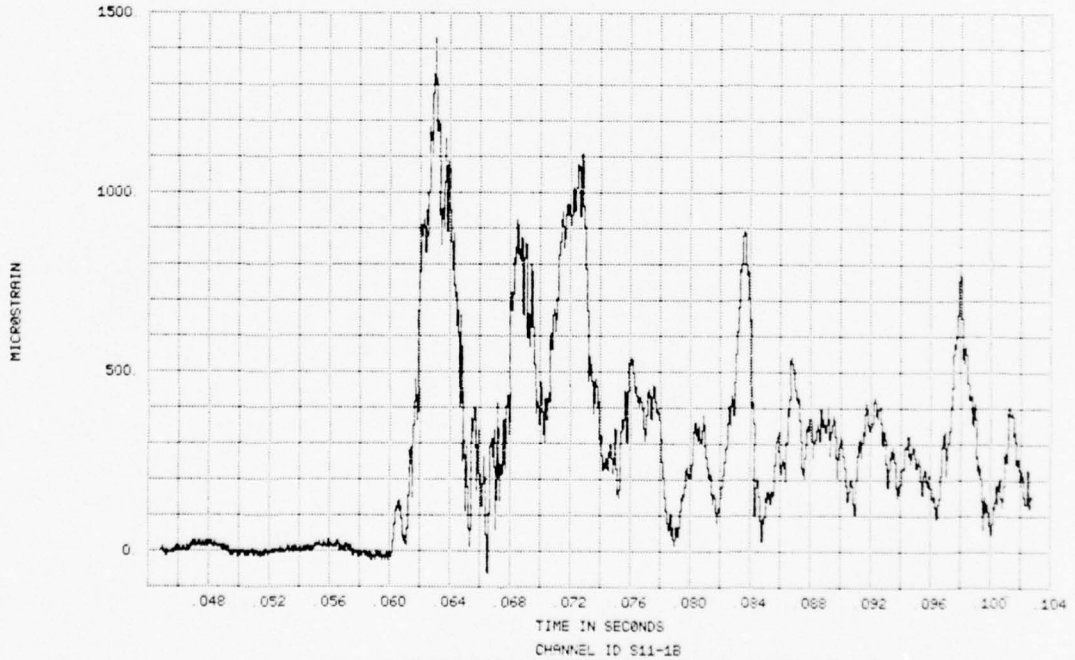


FIGURE 11-16 , SPECIMEN NO. 11 , SHOT NO. 1 ,
STRAIN TIME HISTORY

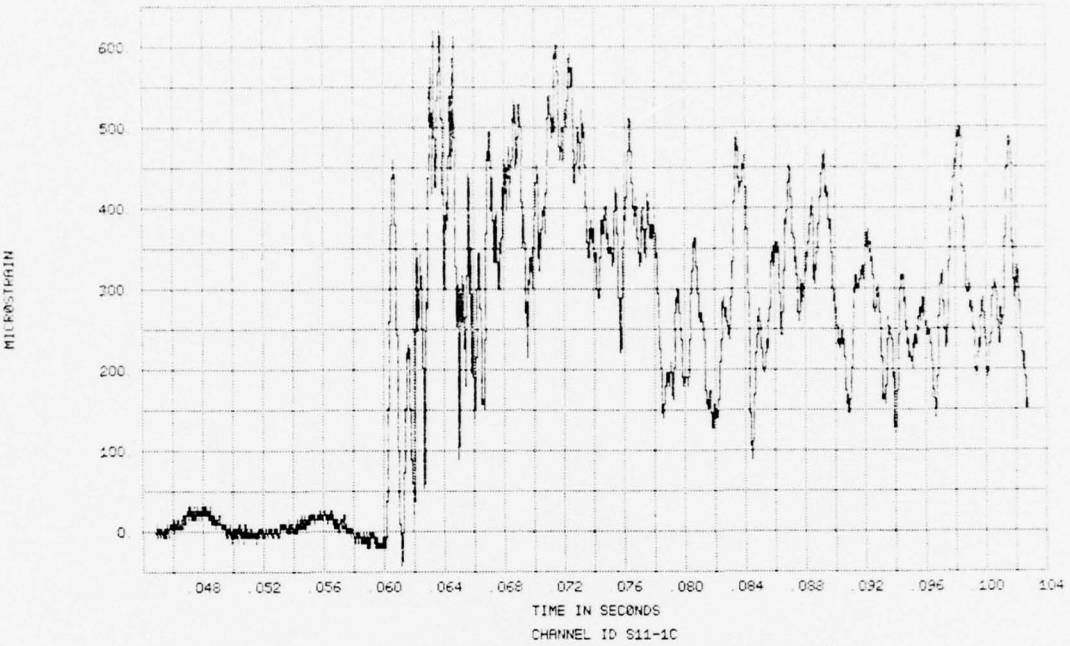


FIGURE 11-17 , SPECIMEN NO. 11 , SHOT NO. 1 ,
STRAIN TIME HISTORY

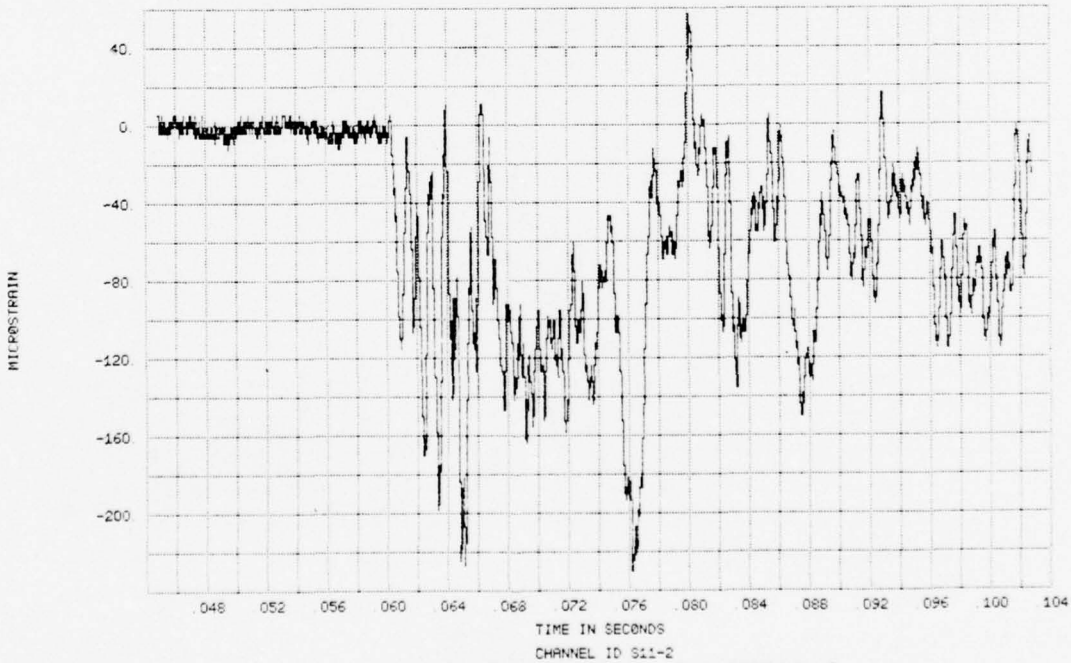


FIGURE 11-18 , SPECIMEN NO. 11 , SHOT NO. 1 ,
STRAIN TIME HISTORY

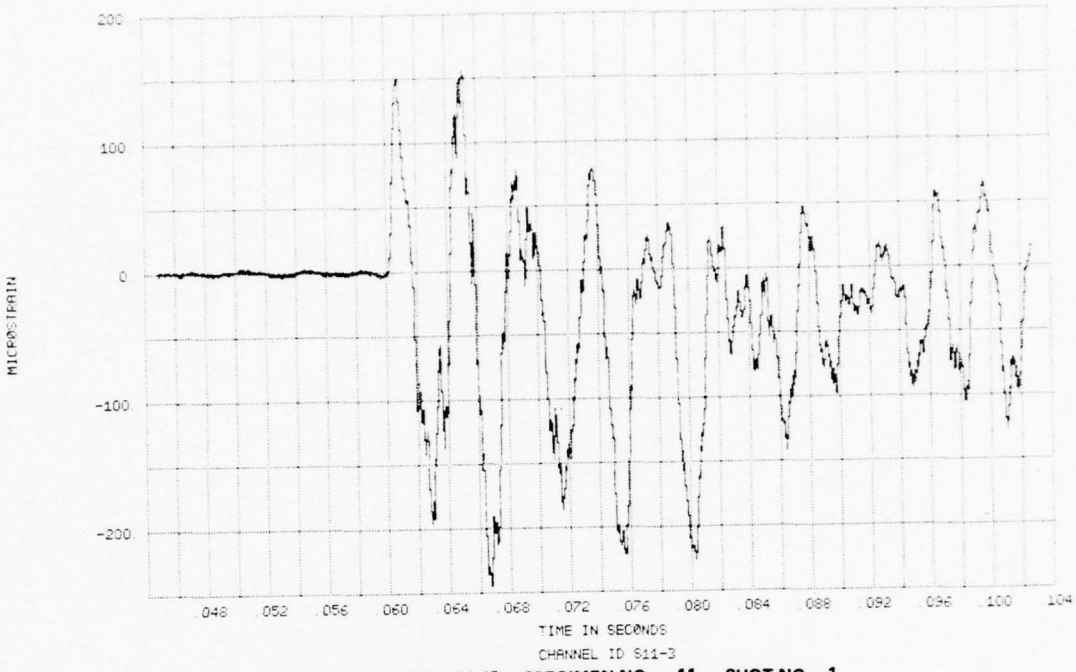


FIGURE 11-19 , SPECIMEN NO. 11 , SHOT NO. 1 , STRAIN TIME HISTORY

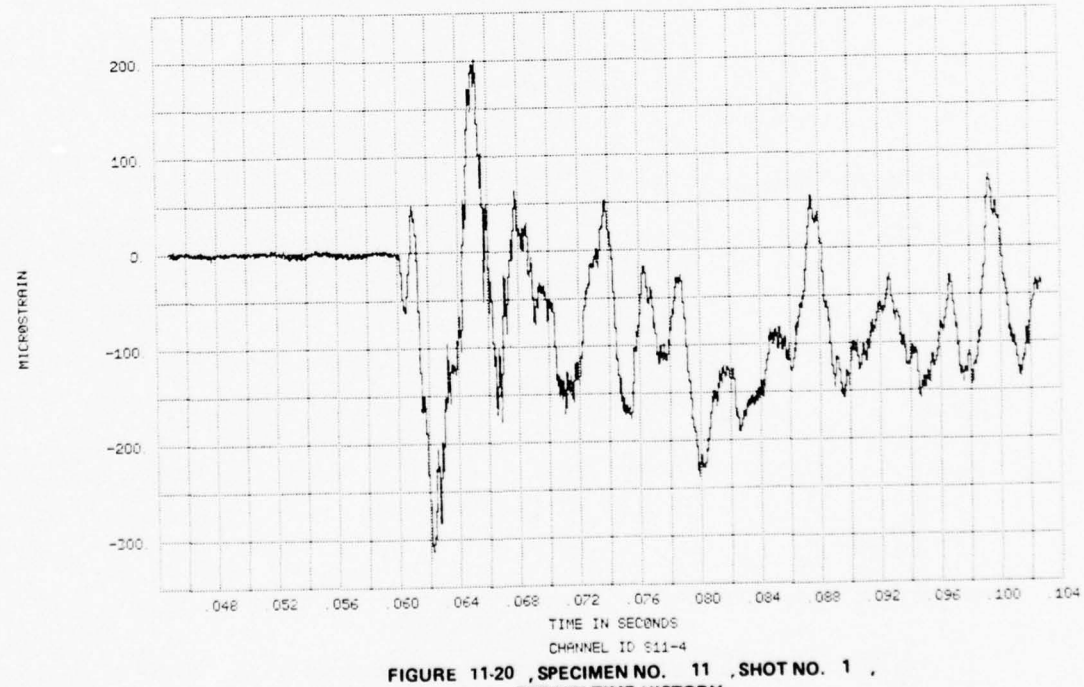


FIGURE 11-20 , SPECIMEN NO. 11 , SHOT NO. 1 , STRAIN TIME HISTORY

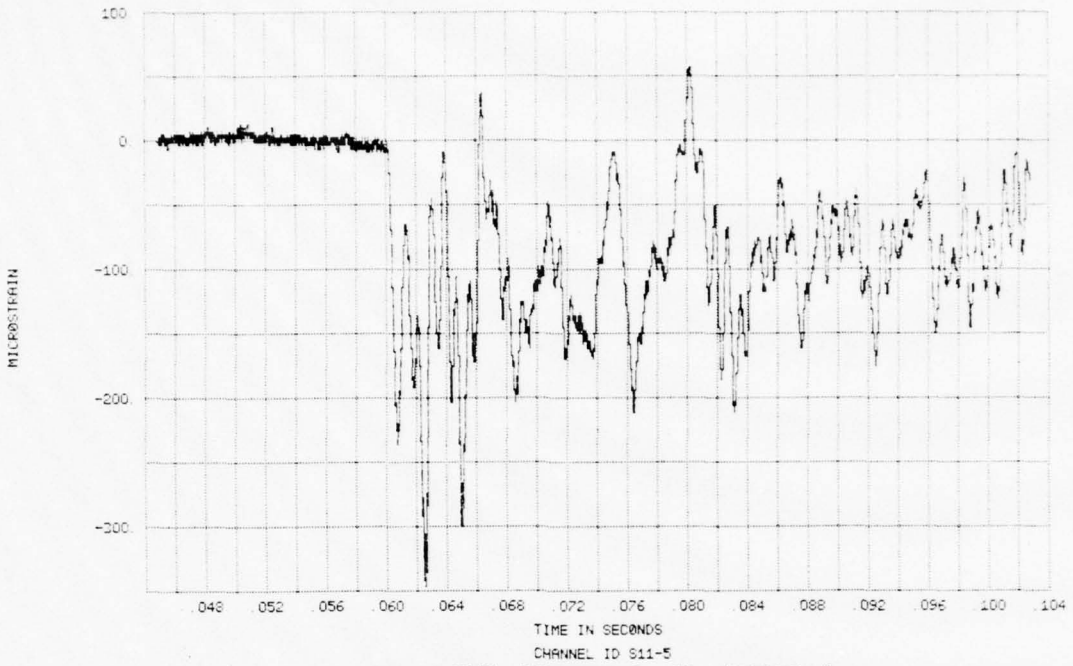


FIGURE 11-21 , SPECIMEN NO. 11 , SHOT NO. 1 ,
STRAIN TIME HISTORY

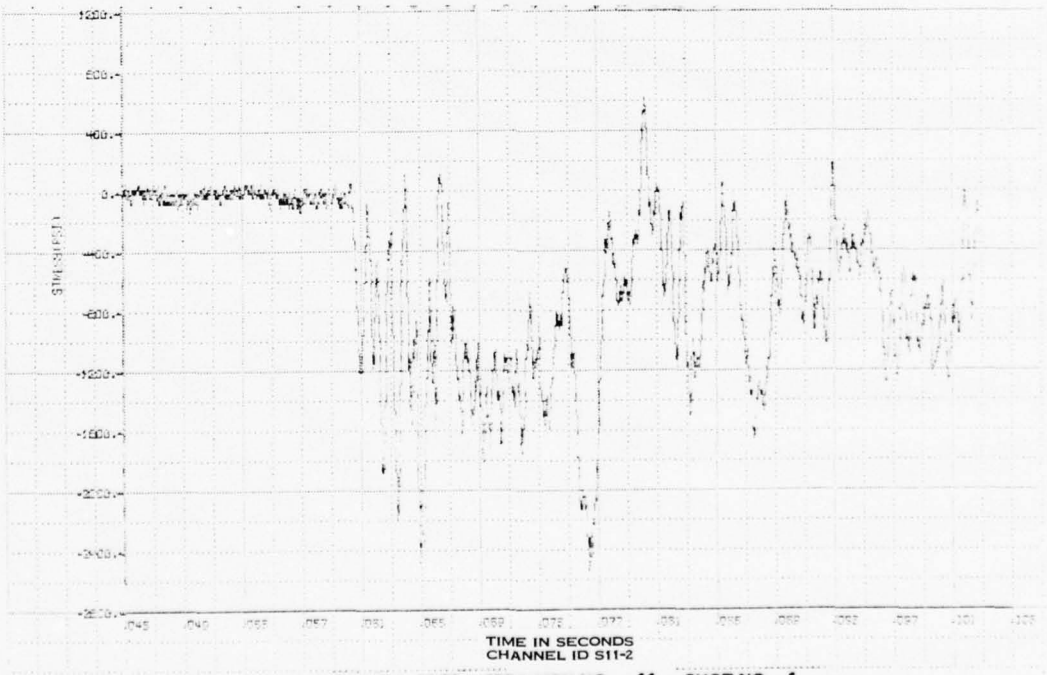


FIGURE 11-22 , SPECIMEN NO. 11 , SHOT NO. 1 ,
STRESS TIME HISTORY

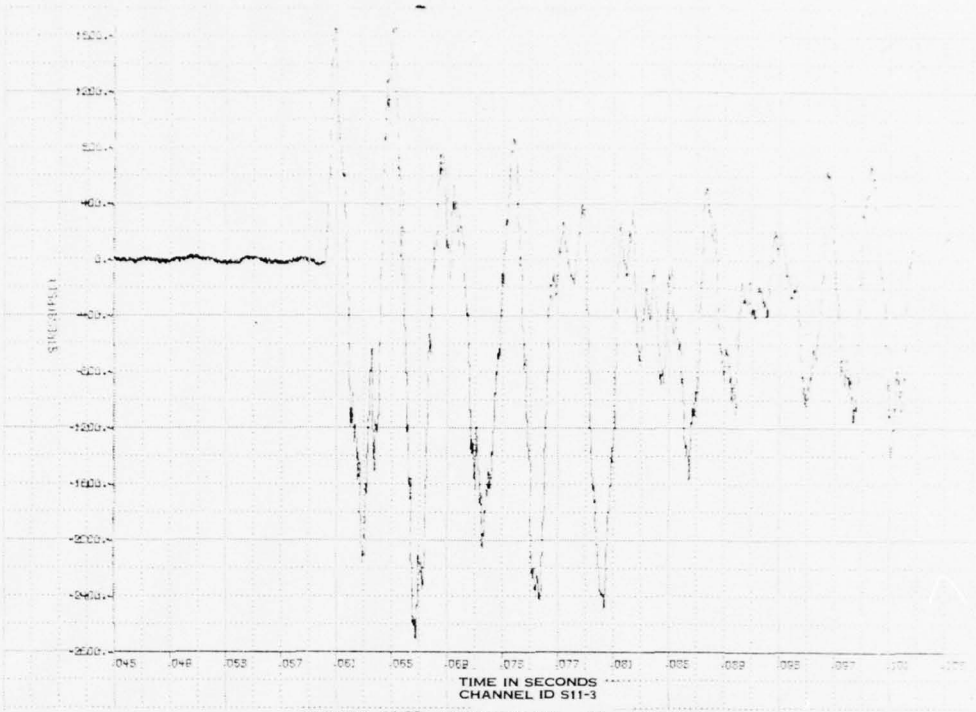


FIGURE 11-23 , SPECIMEN NO. 11 , SHOT NO. 1 ,
STRESS TIME HISTORY

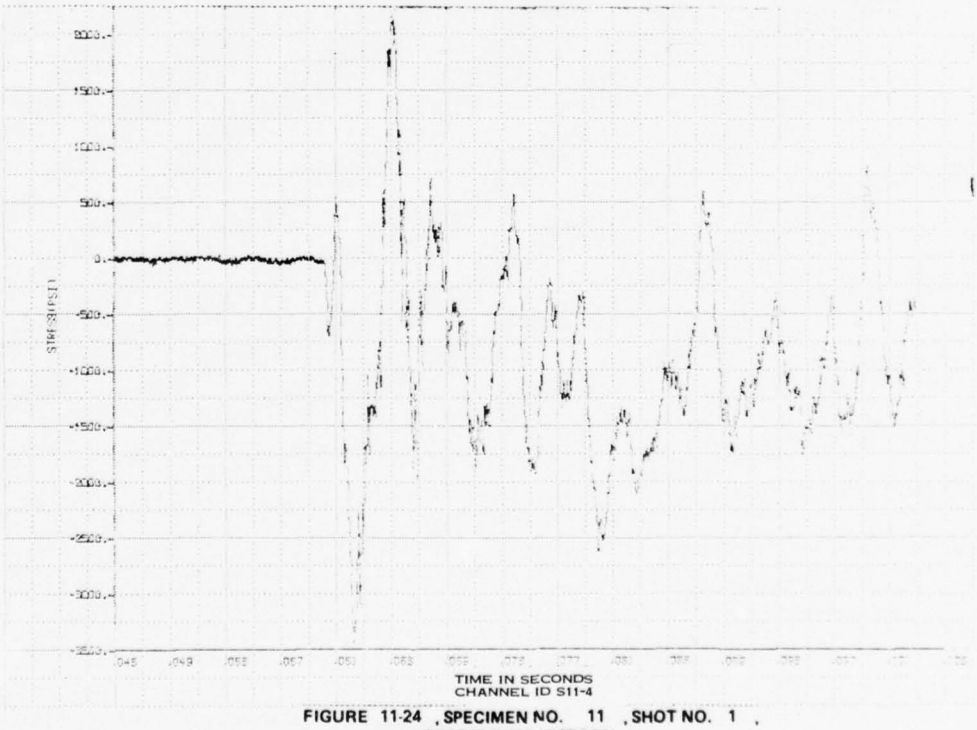


FIGURE 11-24 , SPECIMEN NO. 11 , SHOT NO. 1 ,
STRESS TIME HISTORY

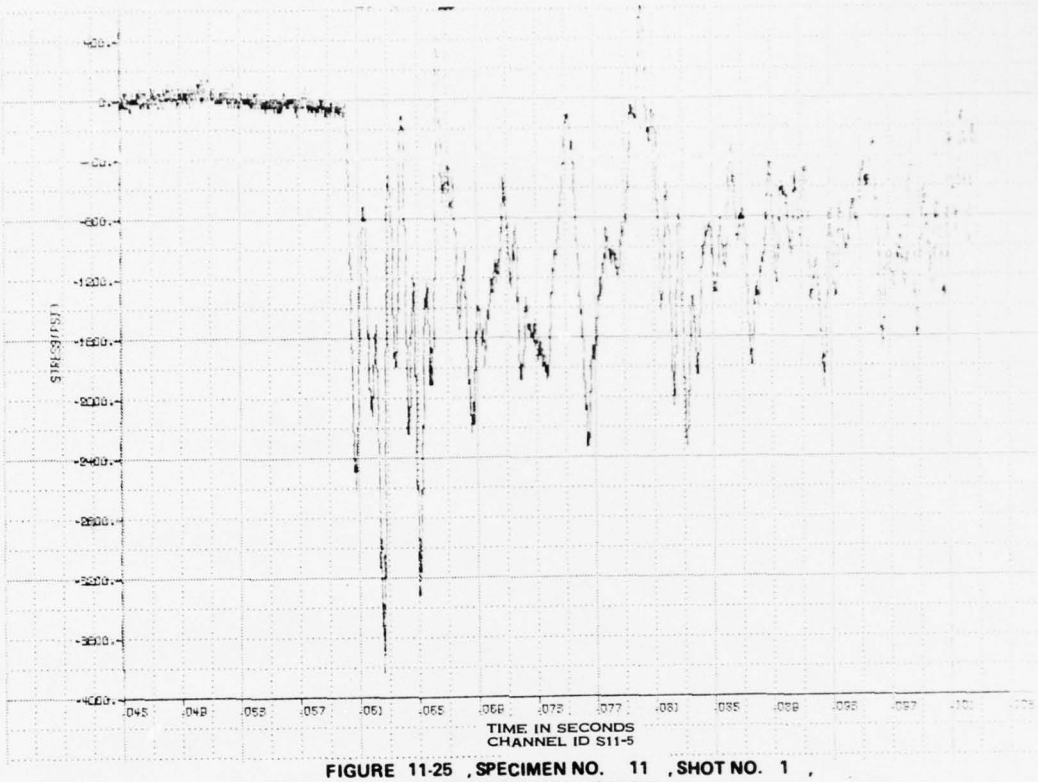


FIGURE 11-25 , SPECIMEN NO. 11 , SHOT NO. 1 ,
STRESS TIME HISTORY

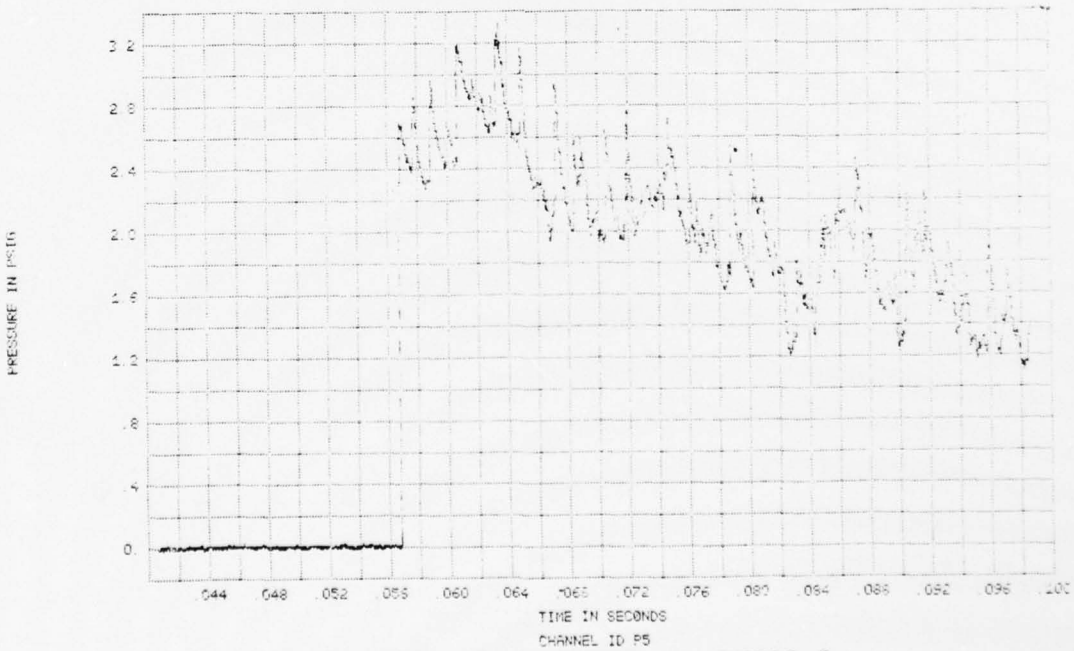


FIGURE 11-26 , SPECIMEN NO. 11 , SHOT NO. 2 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

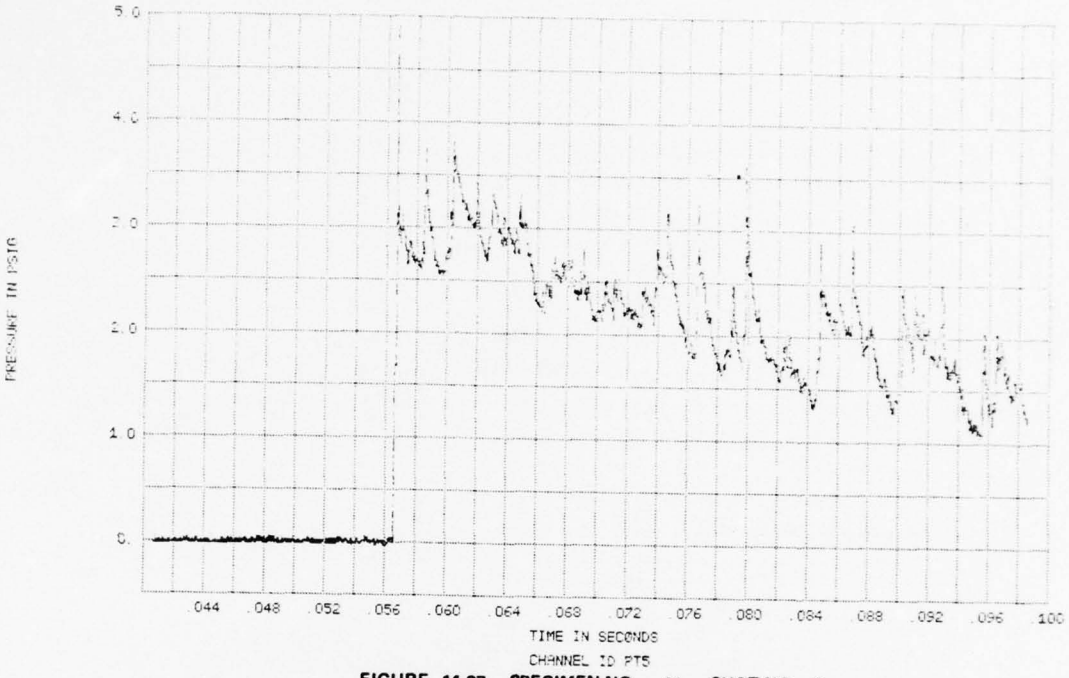


FIGURE 11-27 , SPECIMEN NO. 11 , SHOT NO. 2 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

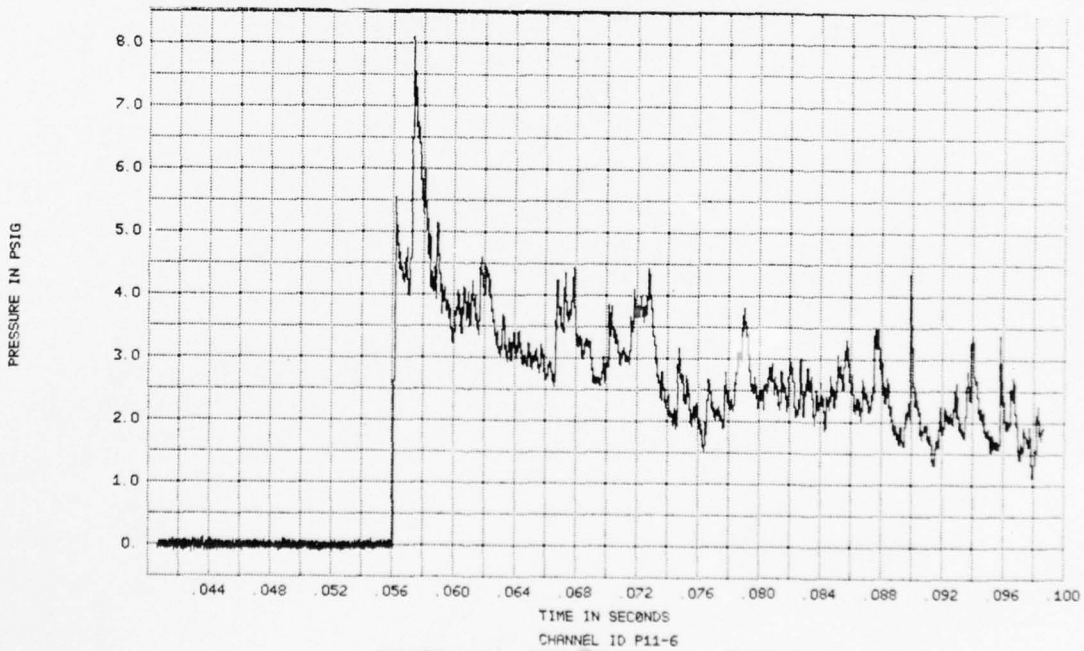


FIGURE 11-28 , SPECIMEN NO. 11 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

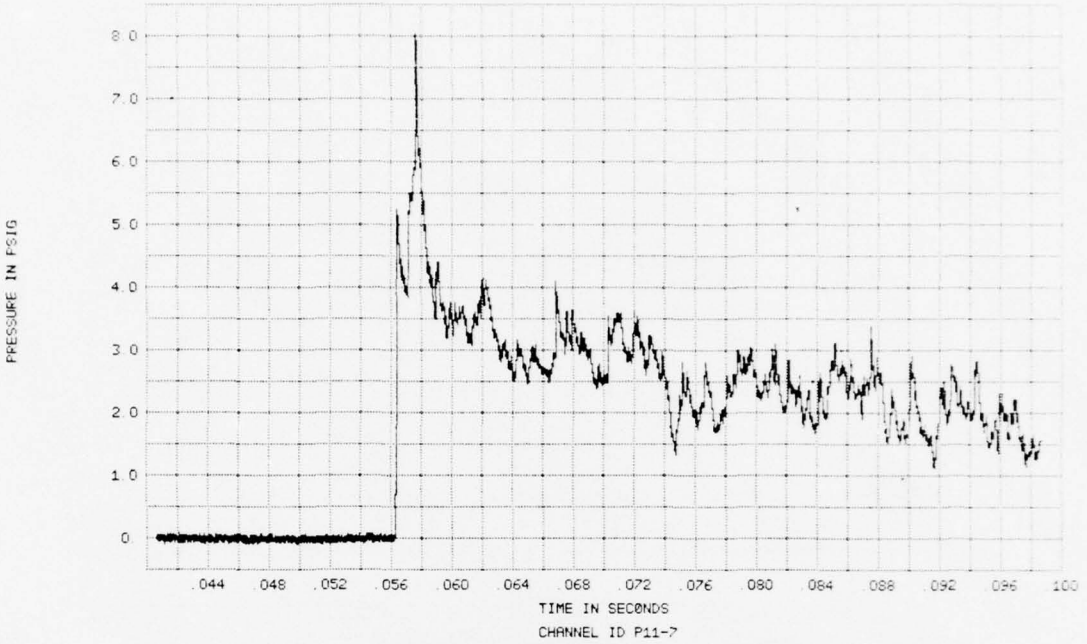


FIGURE 11-29 , SPECIMEN NO. 11 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

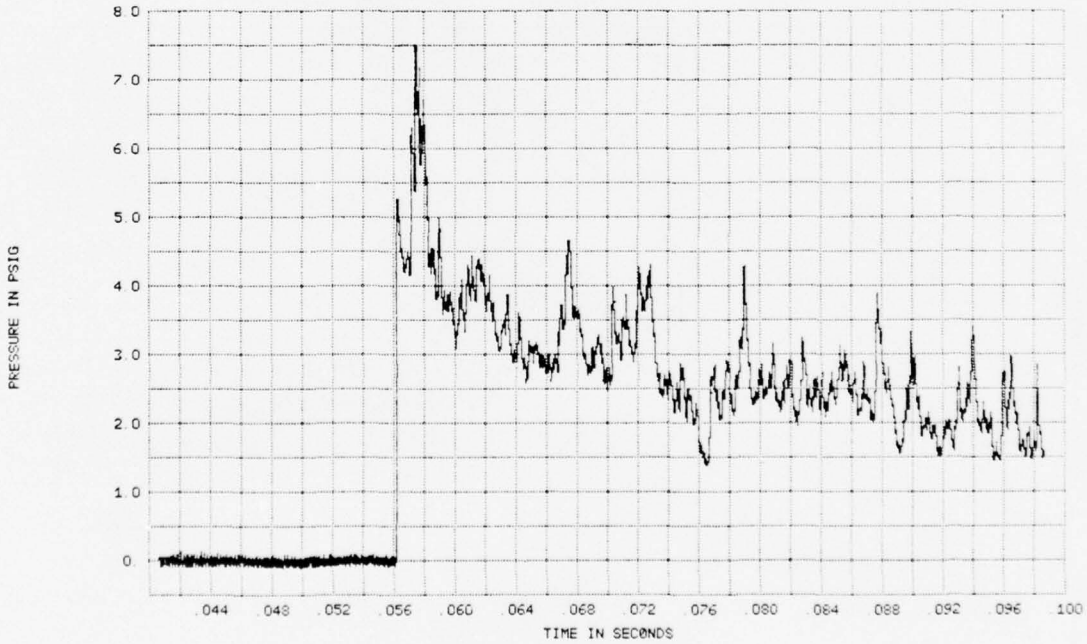


FIGURE 11-30 , SPECIMEN NO. 11 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

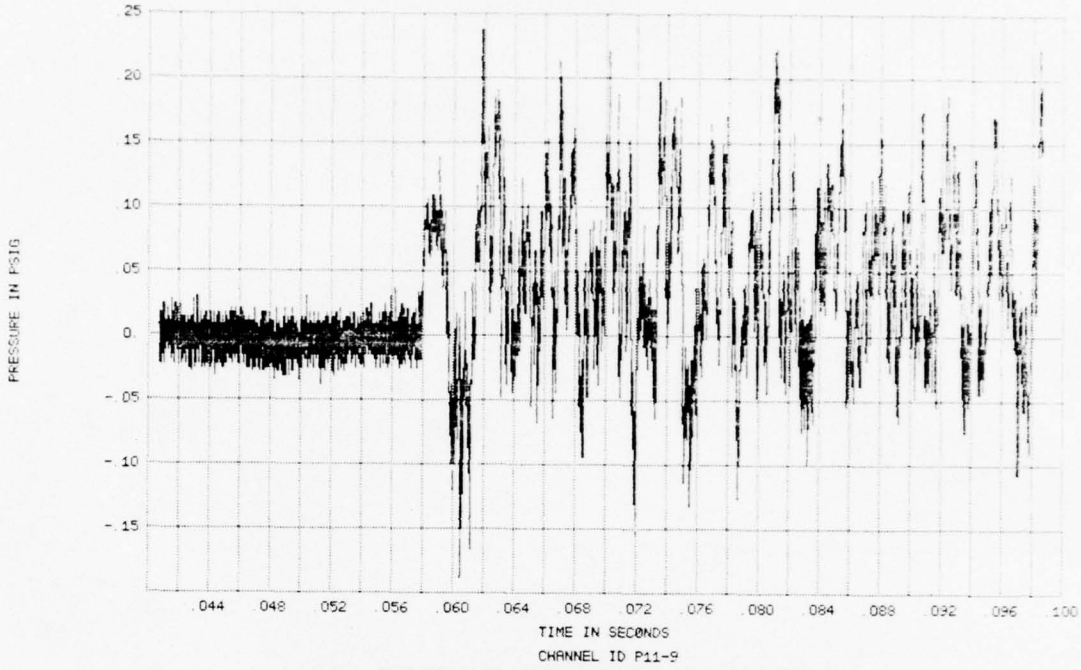


FIGURE 11-31 , SPECIMEN NO. 11 , SHOT NO. 2 ,
INTERNAL PRESSURE TIME HISTORY

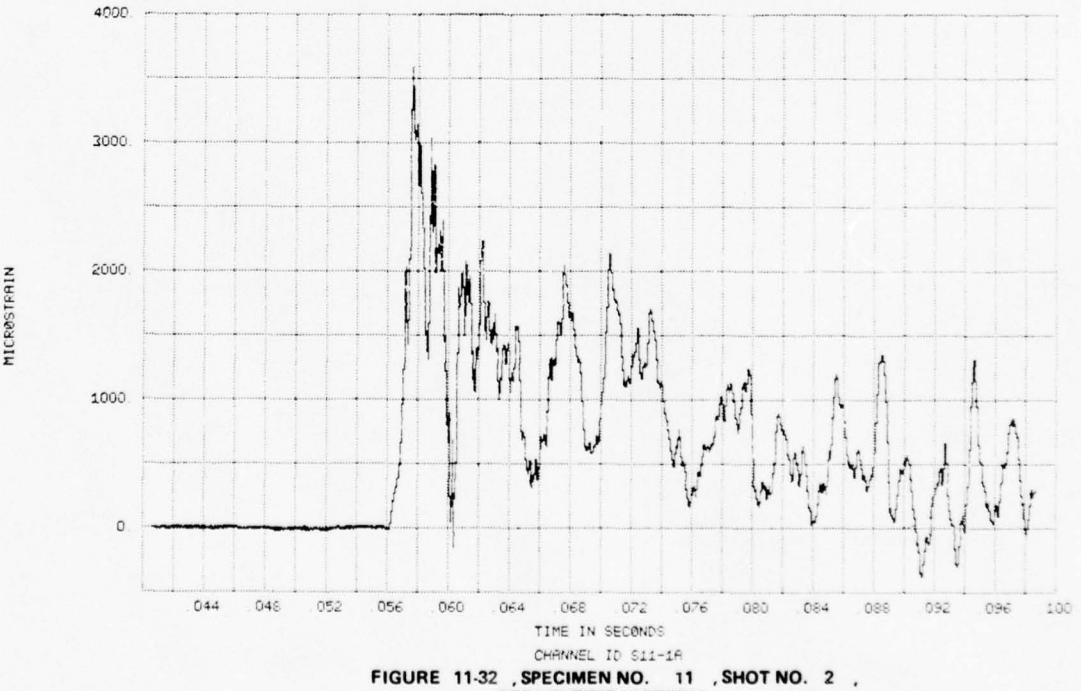


FIGURE 11-32 , SPECIMEN NO. 11 , SHOT NO. 2 ,
STRAIN TIME HISTORY

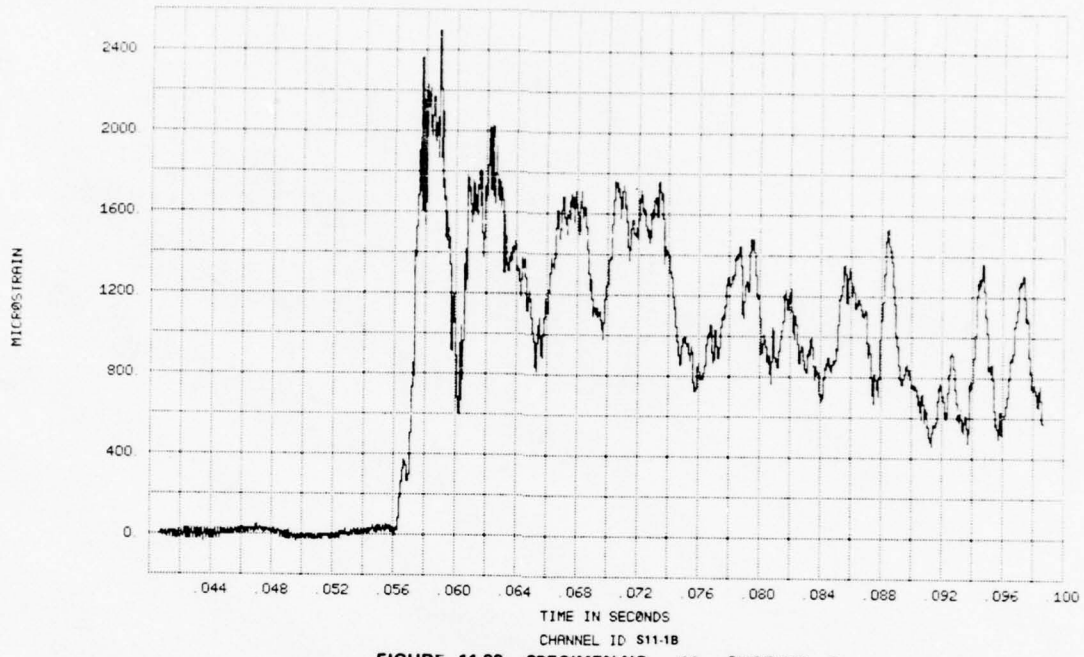


FIGURE 11-33 , SPECIMEN NO. 11 , SHOT NO. 2 ,
STRAIN TIME HISTORY

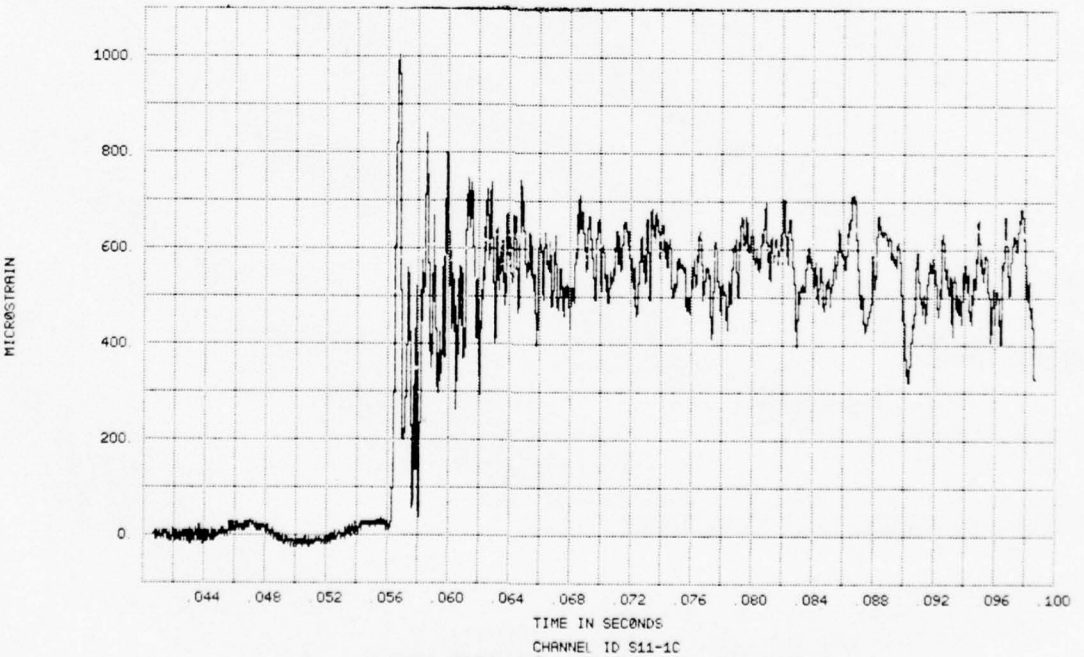


FIGURE 11-34 , SPECIMEN NO. 11 , SHOT NO. 2 ,
STRAIN TIME HISTORY

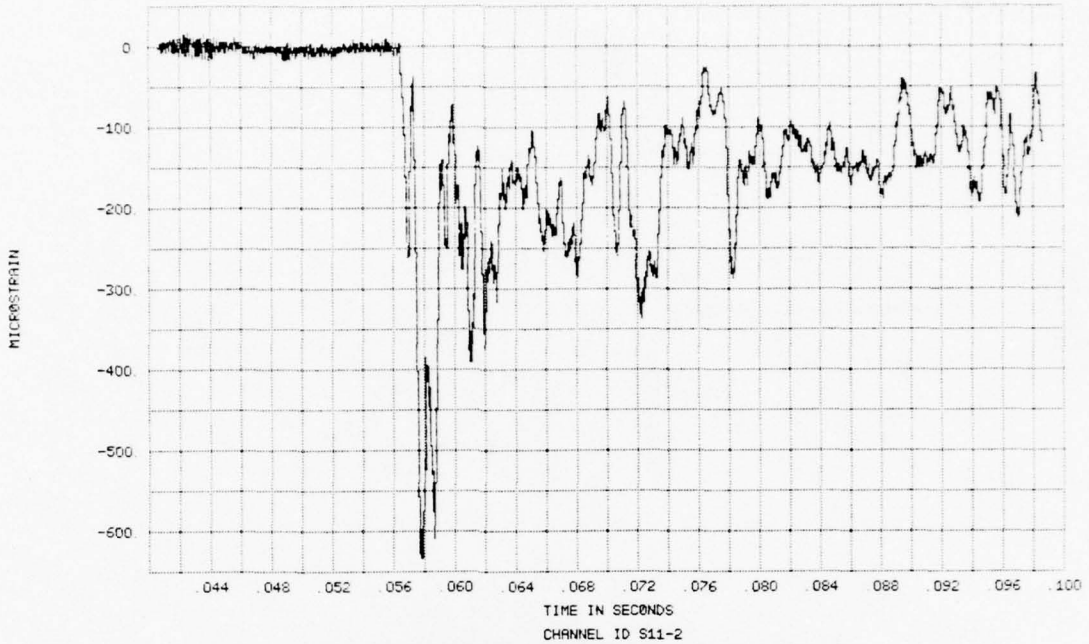


FIGURE 11-35 , SPECIMEN NO. 11 , SHOT NO. 2 ,
STRAIN TIME HISTORY

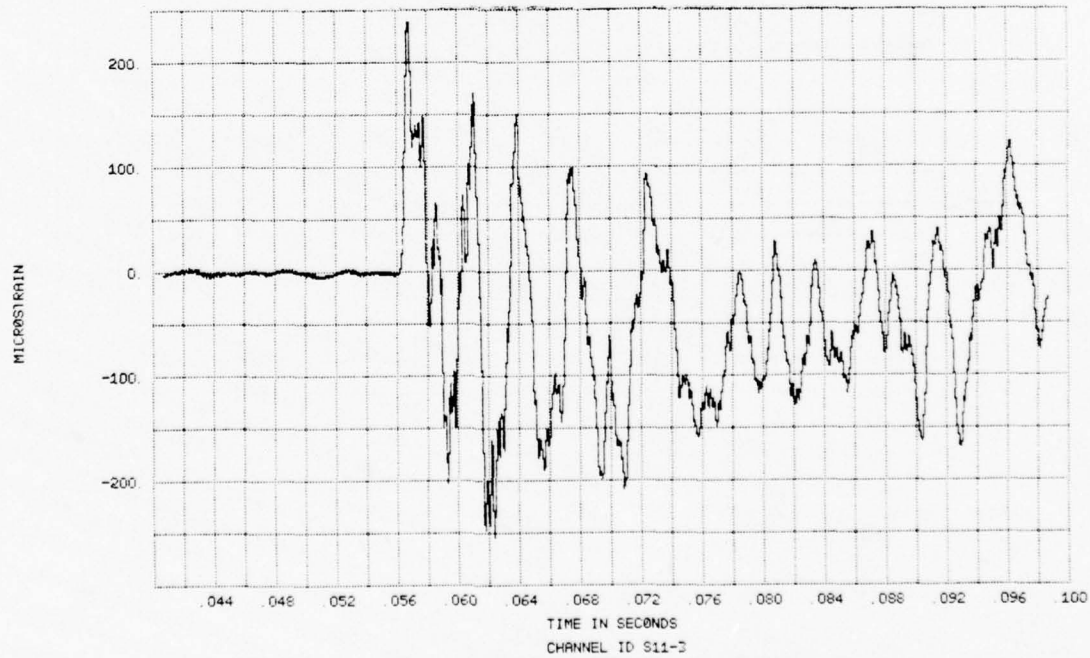


FIGURE 11-36 , SPECIMEN NO. 11 , SHOT NO. 2 ,
STRAIN TIME HISTORY

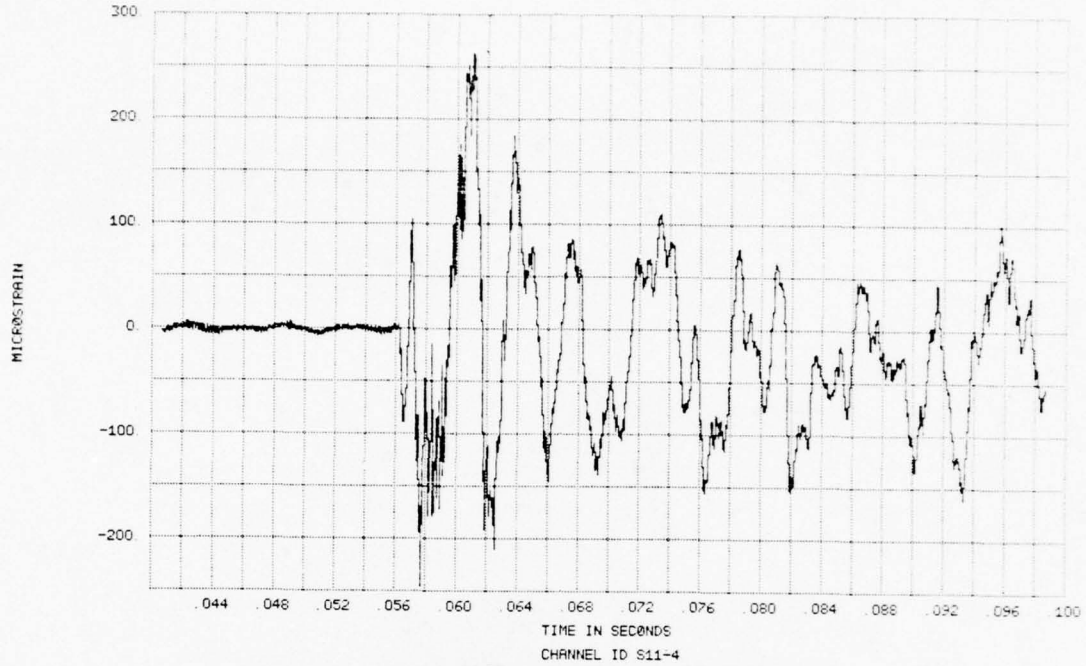


FIGURE 11-37 , SPECIMEN NO. 11 , SHOT NO. 2 ,
STRAIN TIME HISTORY

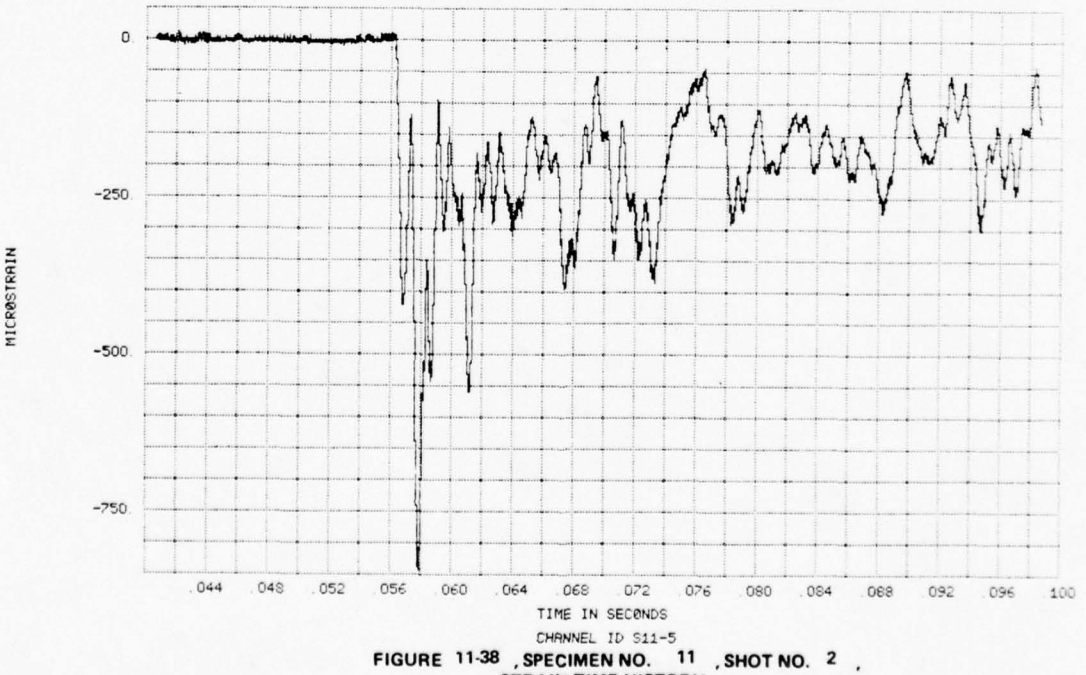


FIGURE 11-38 , SPECIMEN NO. 11 , SHOT NO. 2 ,
STRAIN TIME HISTORY

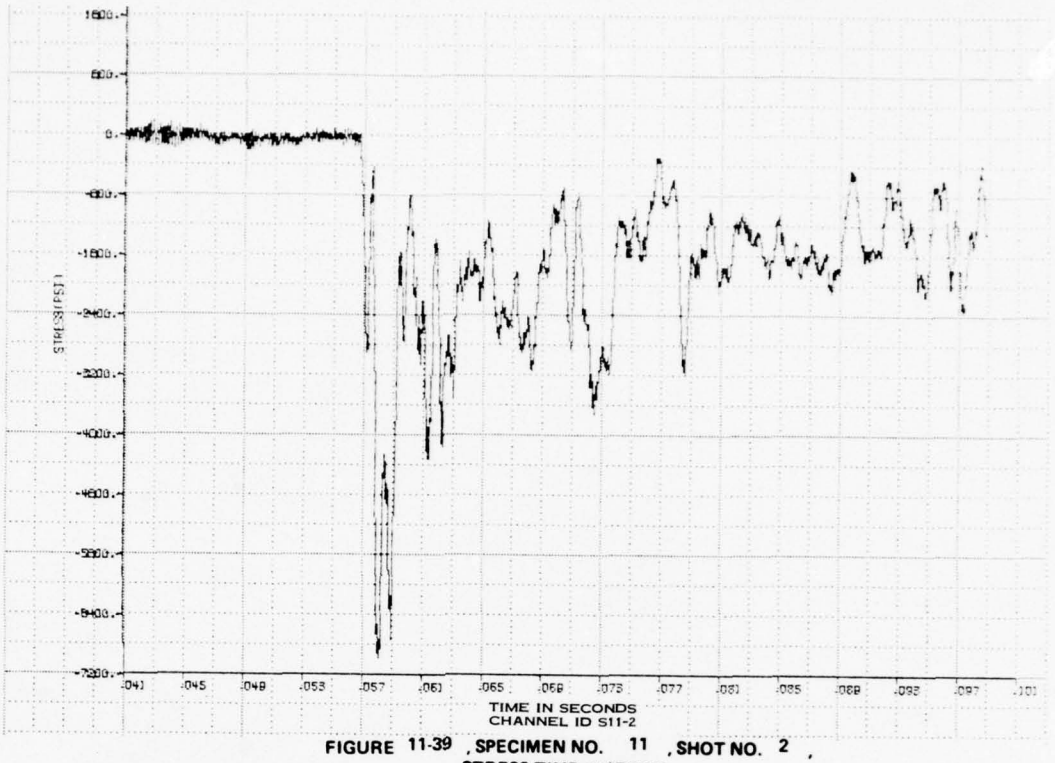


FIGURE 11-39 , SPECIMEN NO. 11 , SHOT NO. 2 ,
STRESS TIME HISTORY

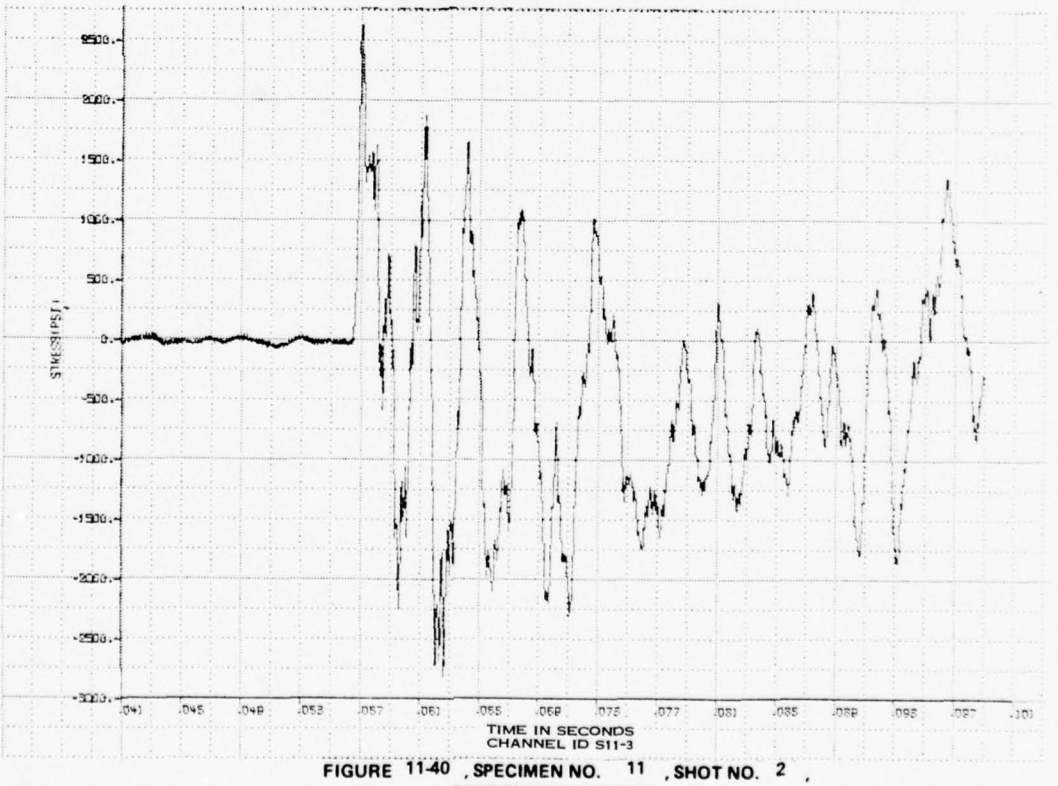


FIGURE 11-40 , SPECIMEN NO. 11 , SHOT NO. 2 ,
STRESS TIME HISTORY

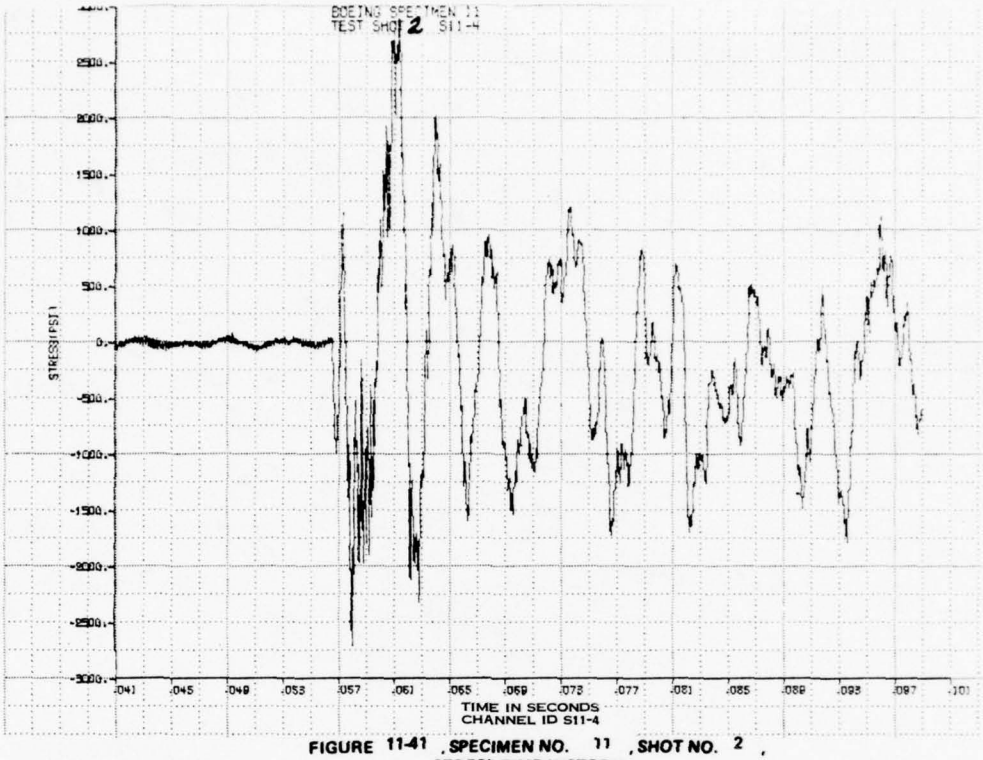


FIGURE 11-41 , SPECIMEN NO. 11 , SHOT NO. 2 ,
STRESS TIME HISTORY

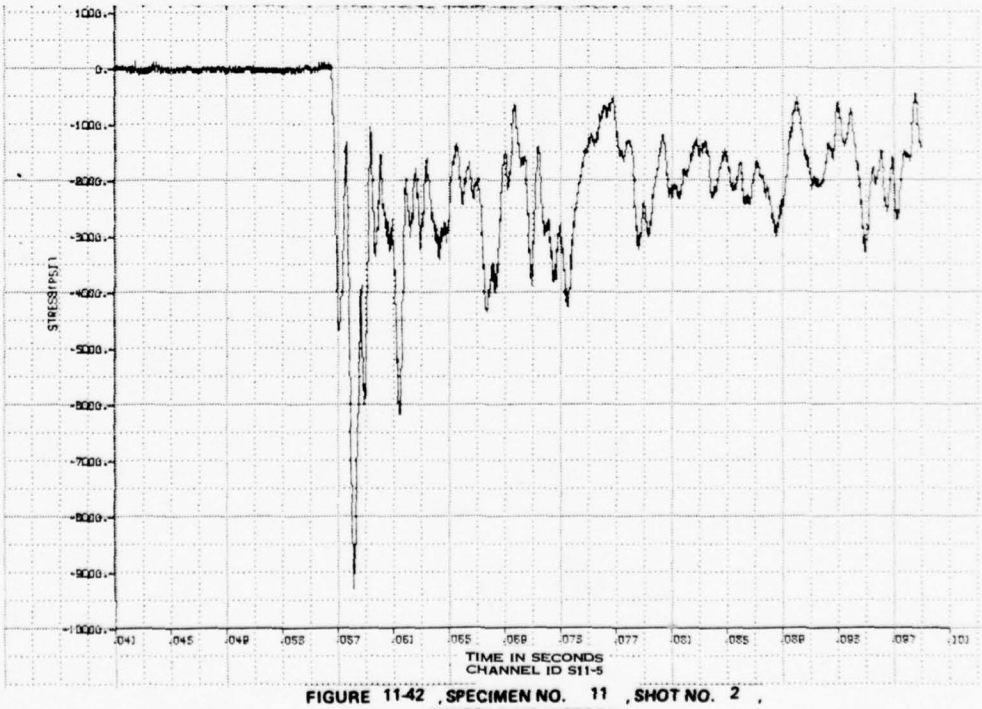


FIGURE 11-42 , SPECIMEN NO. 11 , SHOT NO. 2 ,
STRESS TIME HISTORY

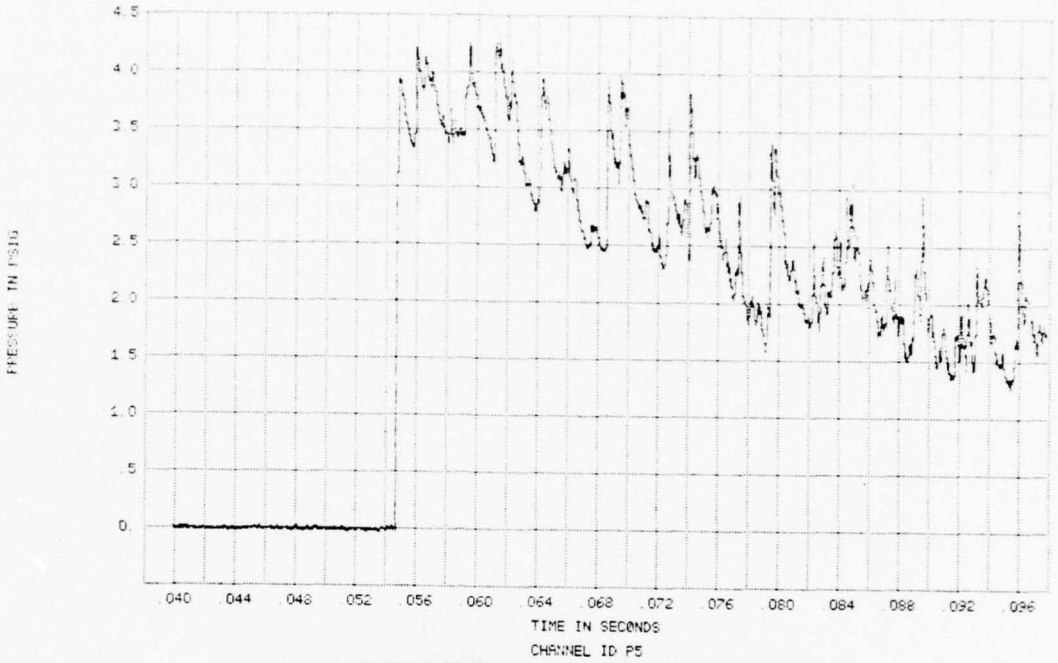


FIGURE 11-43 , SPECIMEN NO. 11 , SHOT NO. 3 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

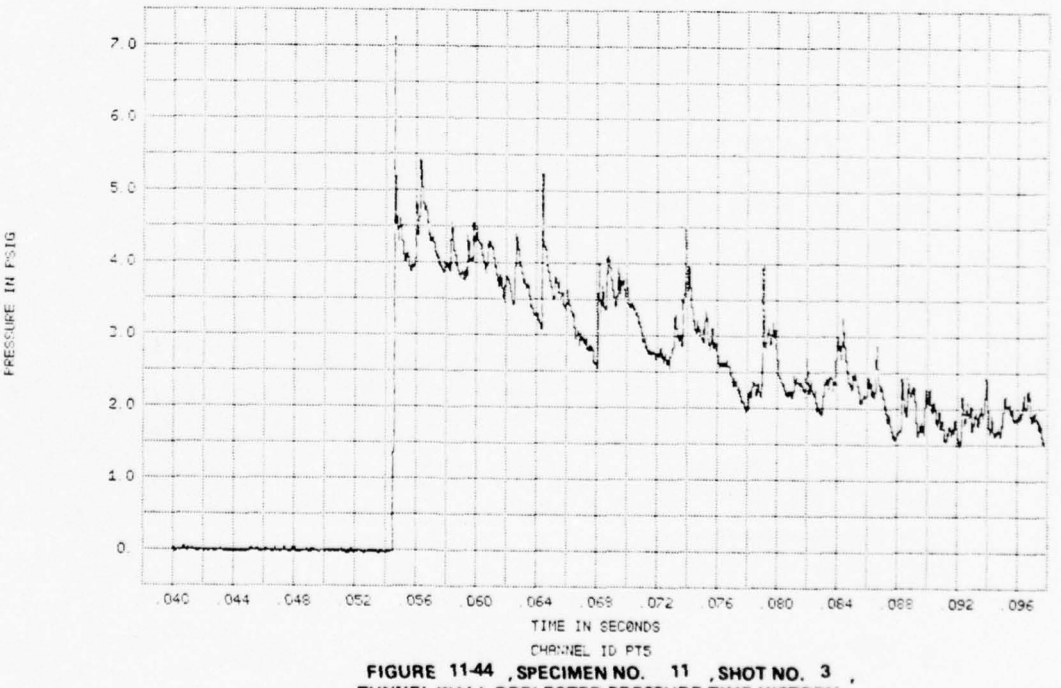


FIGURE 11-44 , SPECIMEN NO. 11 , SHOT NO. 3 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

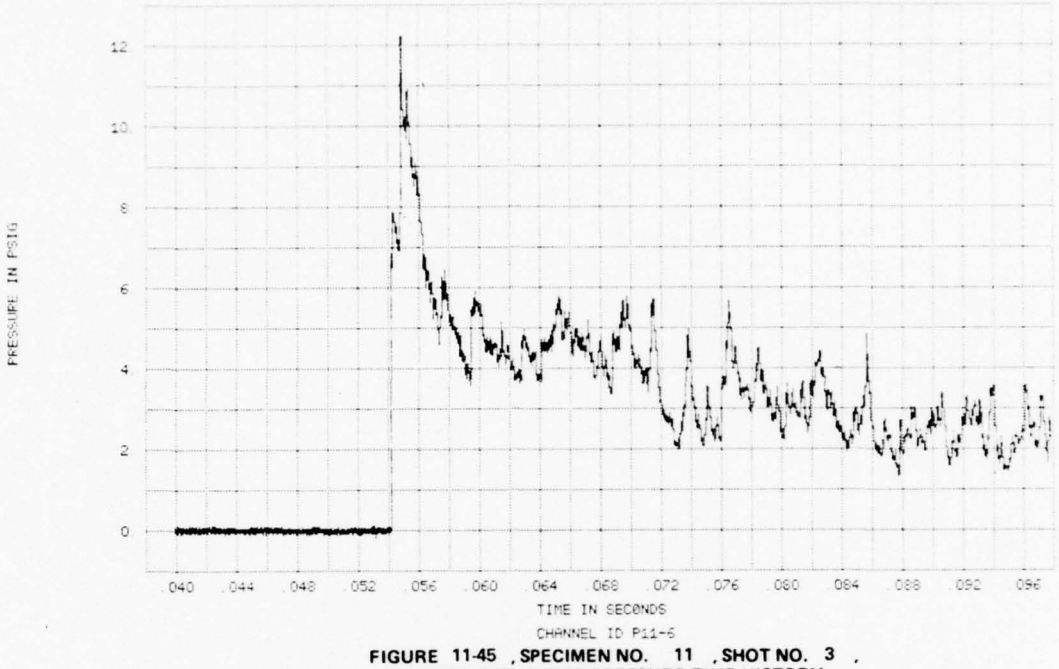


FIGURE 11-45 , SPECIMEN NO. 11 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

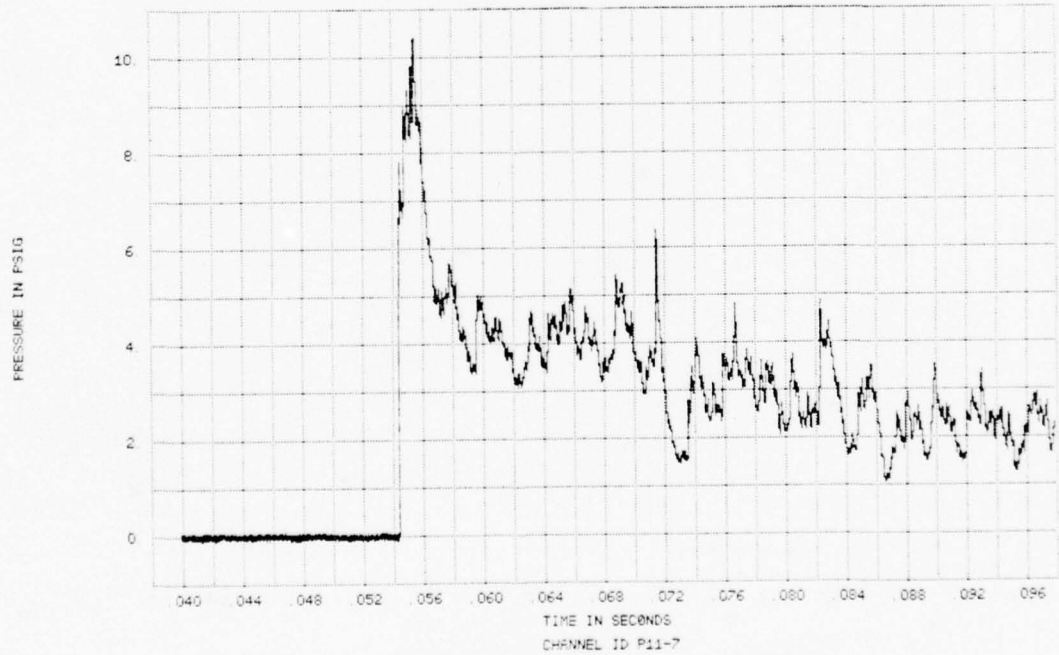


FIGURE 11-46 , SPECIMEN NO. 11 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

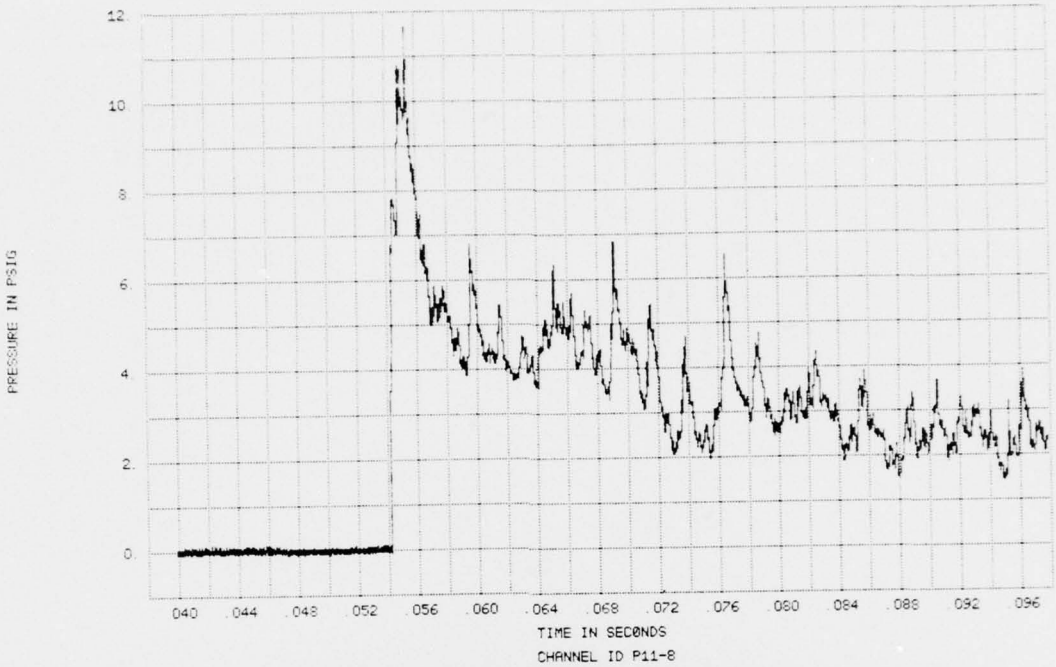


FIGURE 11-47 , SPECIMEN NO. 11 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

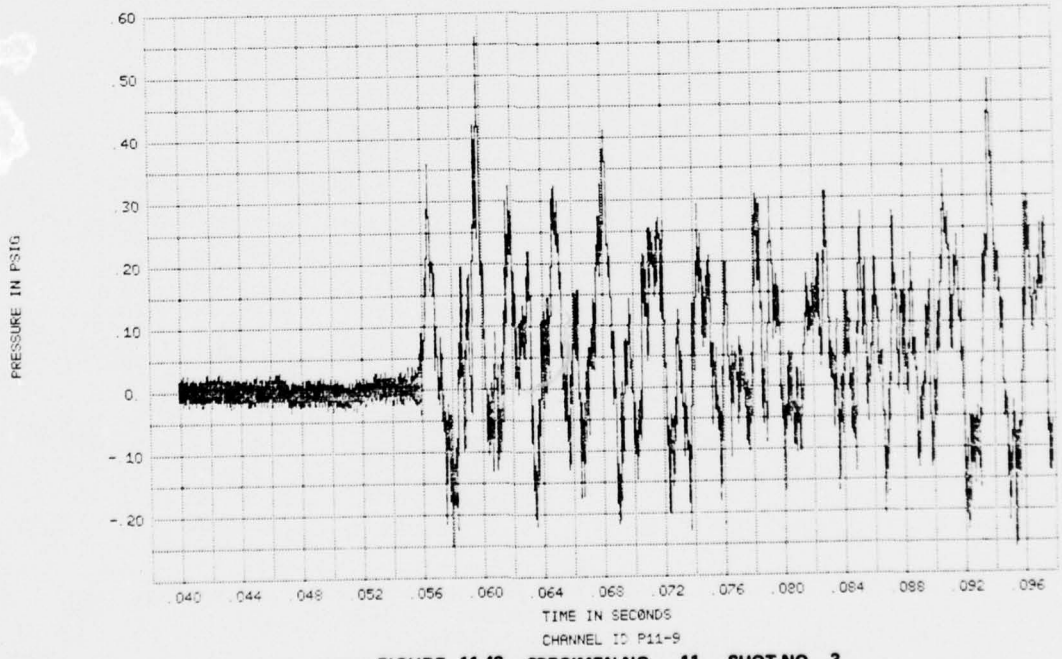


FIGURE 11-48 , SPECIMEN NO. 11 , SHOT NO. 3 ,
INTERNAL PRESSURE TIME HISTORY

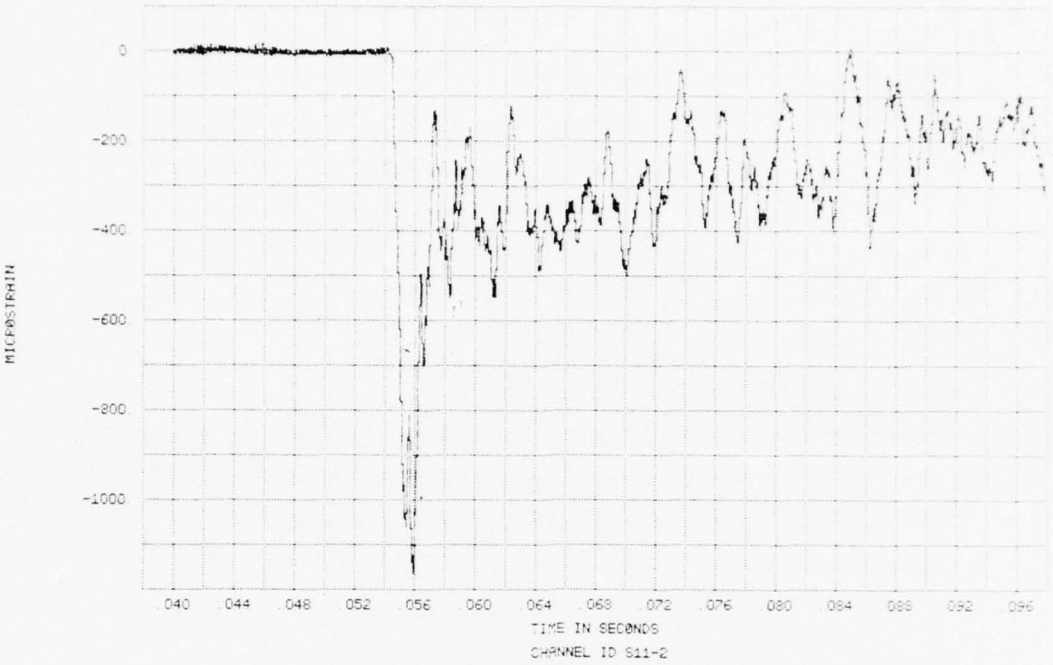


FIGURE 11-49 , SPECIMEN NO. 11 , SHOT NO. 3 , STRAIN TIME HISTORY

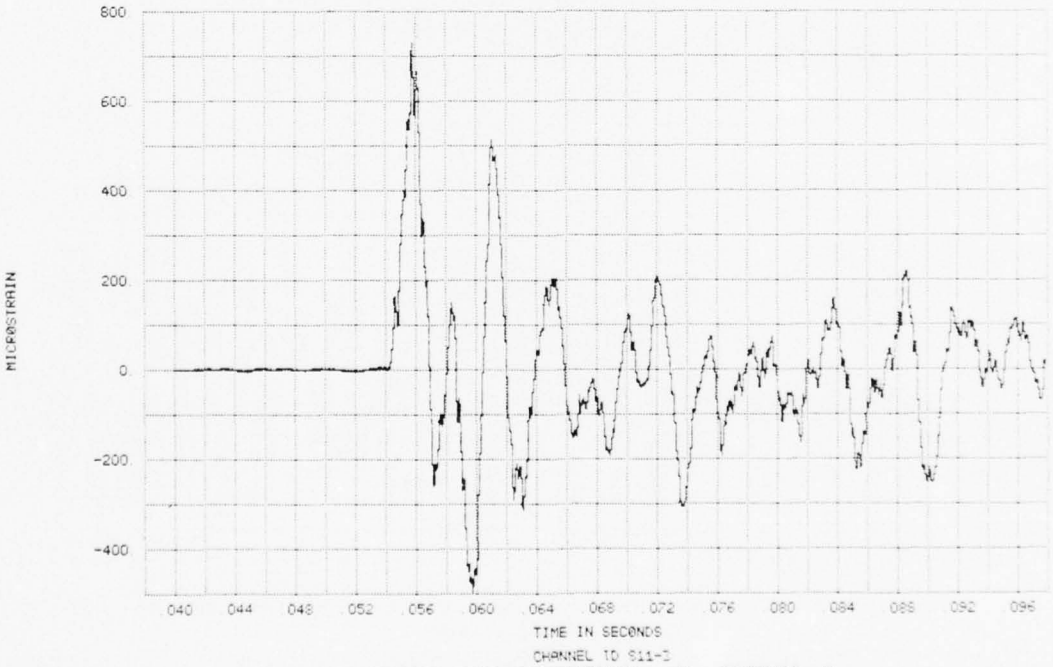


FIGURE 11-50 , SPECIMEN NO. 11 , SHOT NO. 3 , STRAIN TIME HISTORY

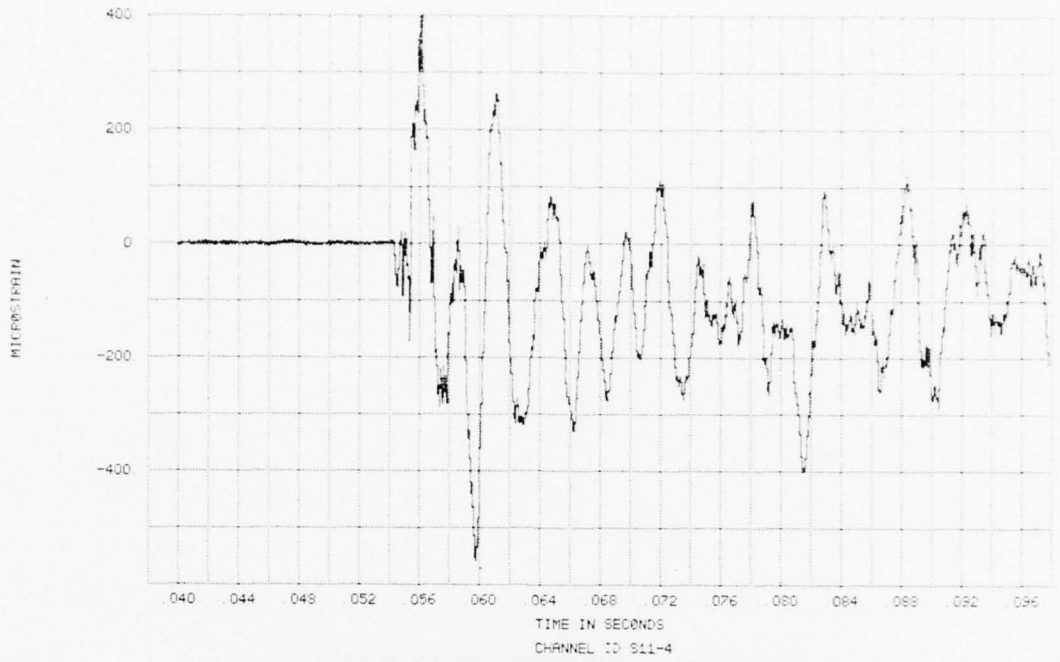


FIGURE 11-51 , SPECIMEN NO. 11 , SHOT NO. 3 , STRAIN TIME HISTORY

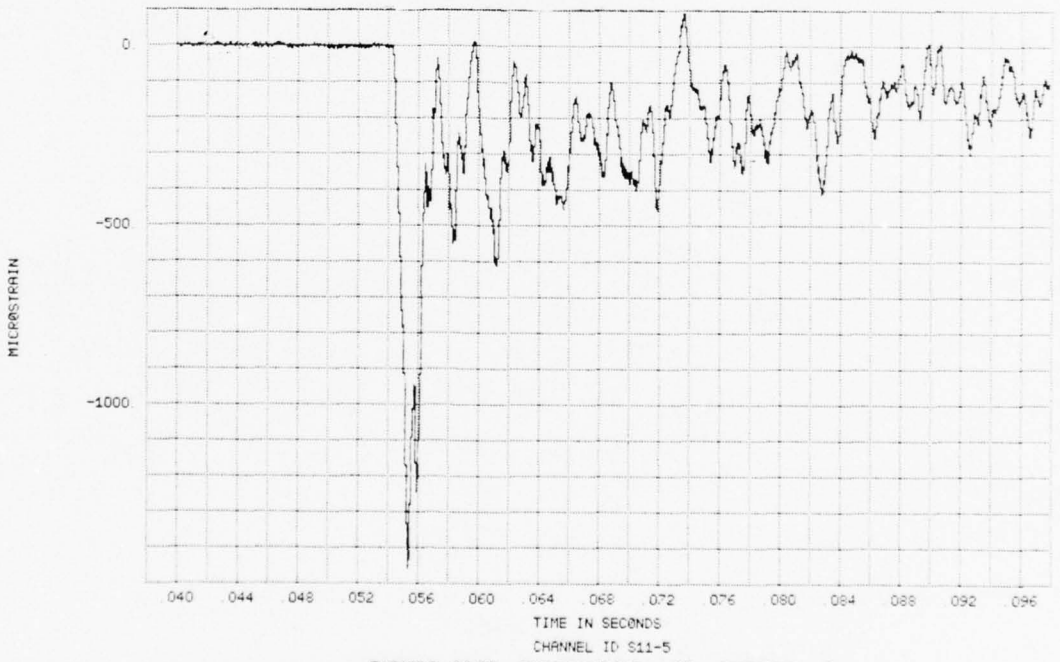


FIGURE 11-52 , SPECIMEN NO. 11 , SHOT NO. 3 , STRAIN TIME HISTORY

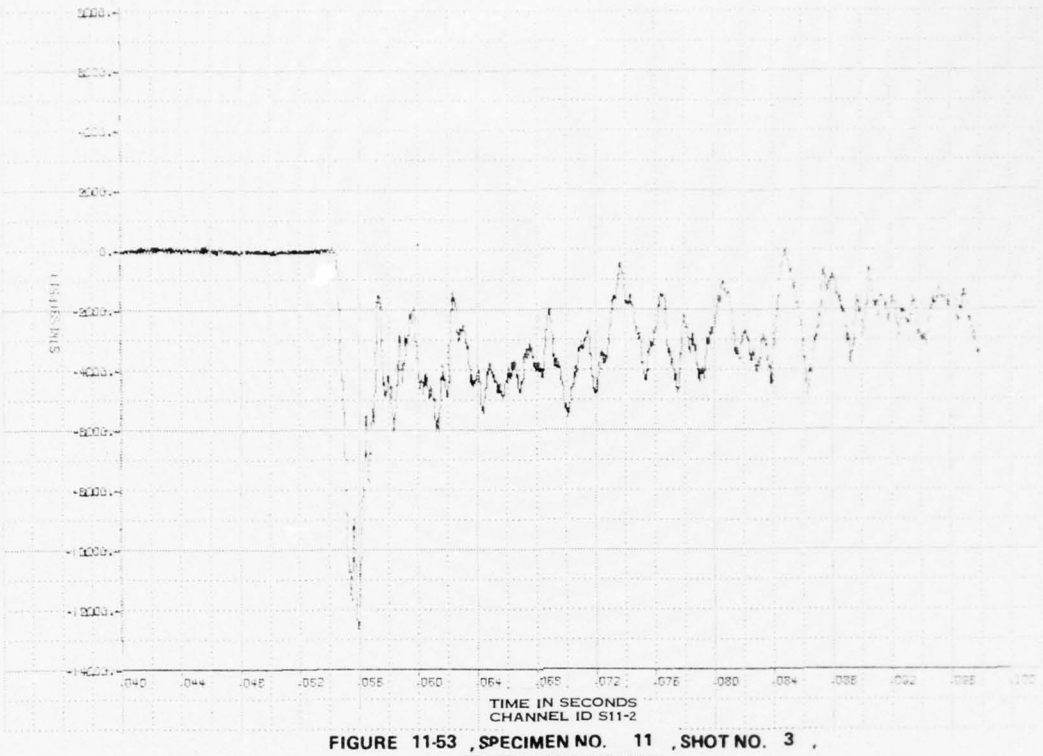


FIGURE 11-53 , SPECIMEN NO. 11 , SHOT NO. 3 ,
STRESS TIME HISTORY

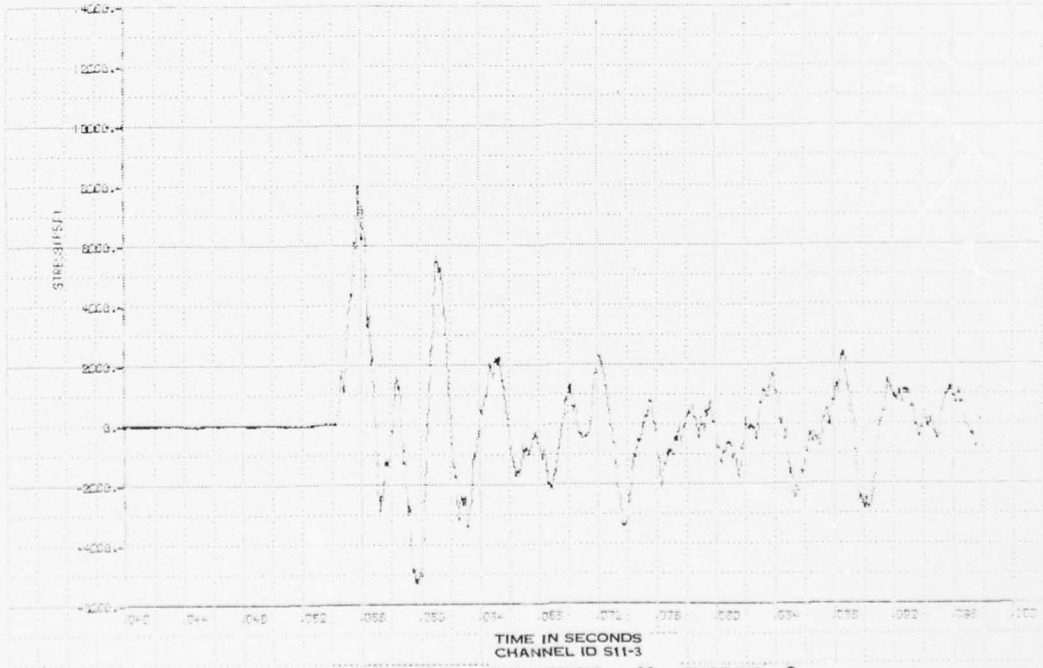


FIGURE 11-54 , SPECIMEN NO. 11 , SHOT NO. 3
STRESS TIME HISTORY

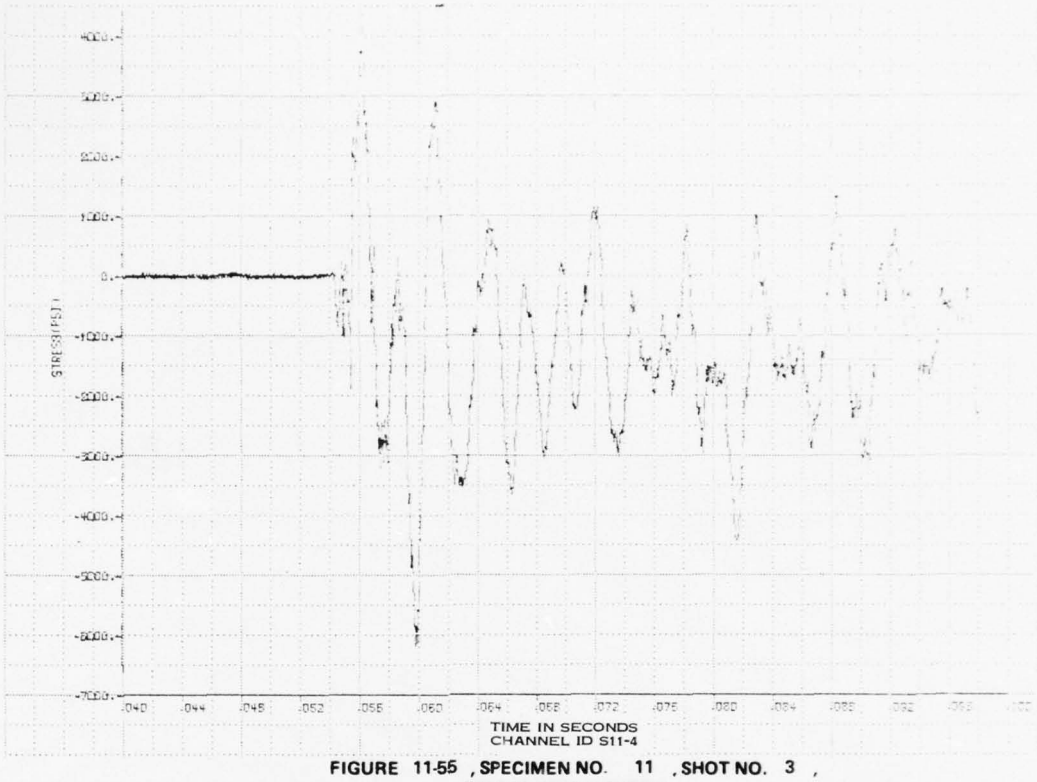


FIGURE 11-55 , SPECIMEN NO. 11 , SHOT NO. 3 ,
STRESS TIME HISTORY

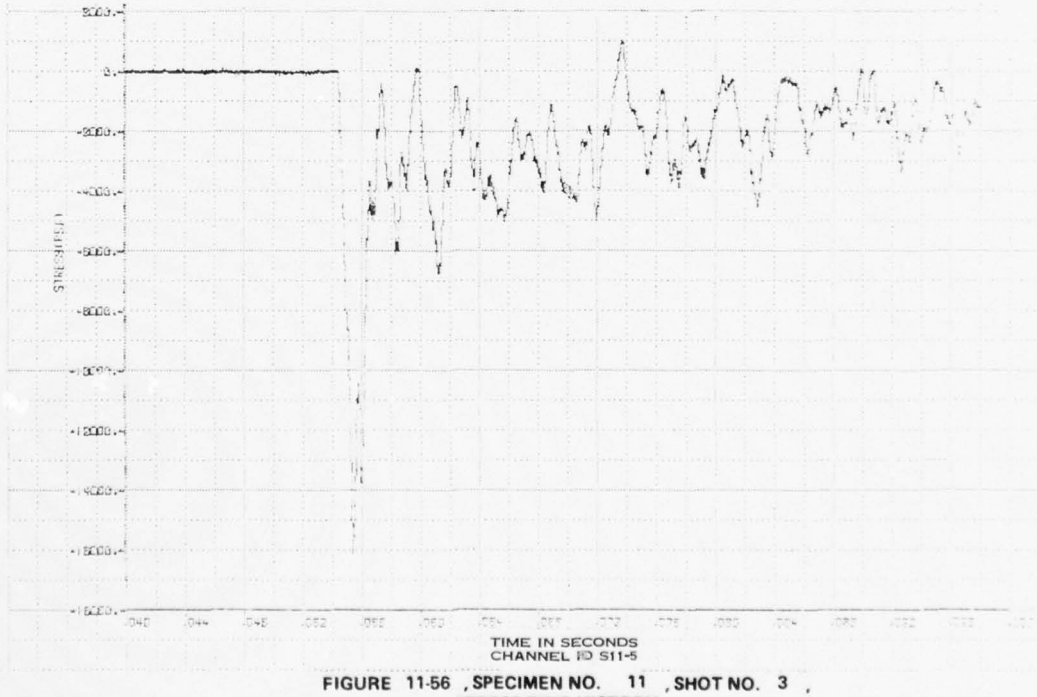


FIGURE 11-56 , SPECIMEN NO. 11 , SHOT NO. 3 ,
STRESS TIME HISTORY

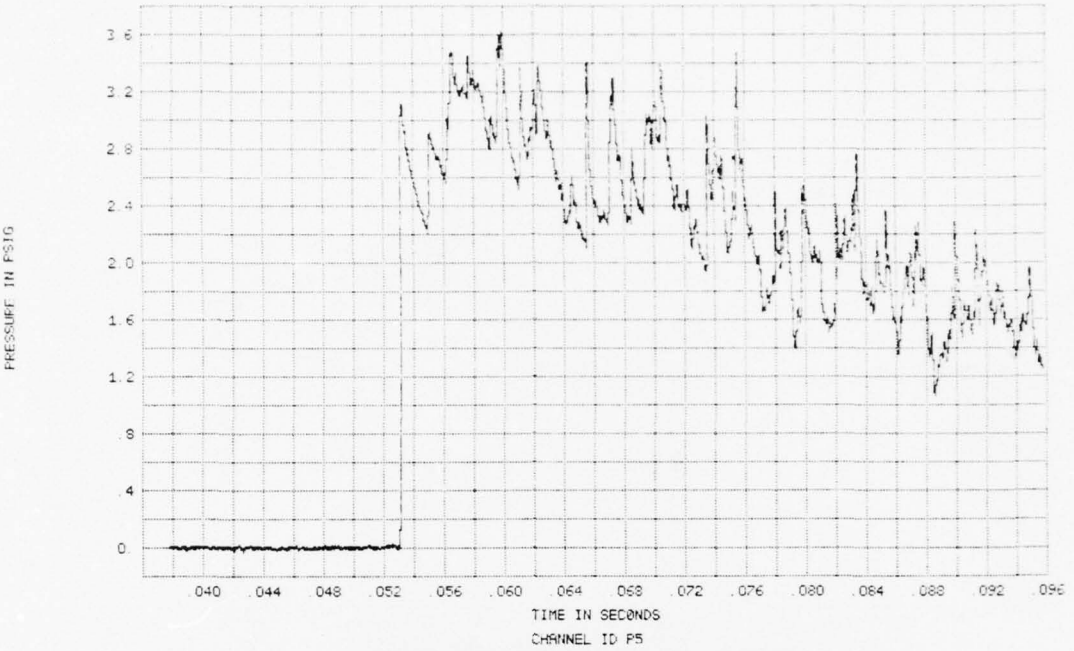


FIGURE 11-57 , SPECIMEN NO. 11 , SHOT NO. 4 .
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

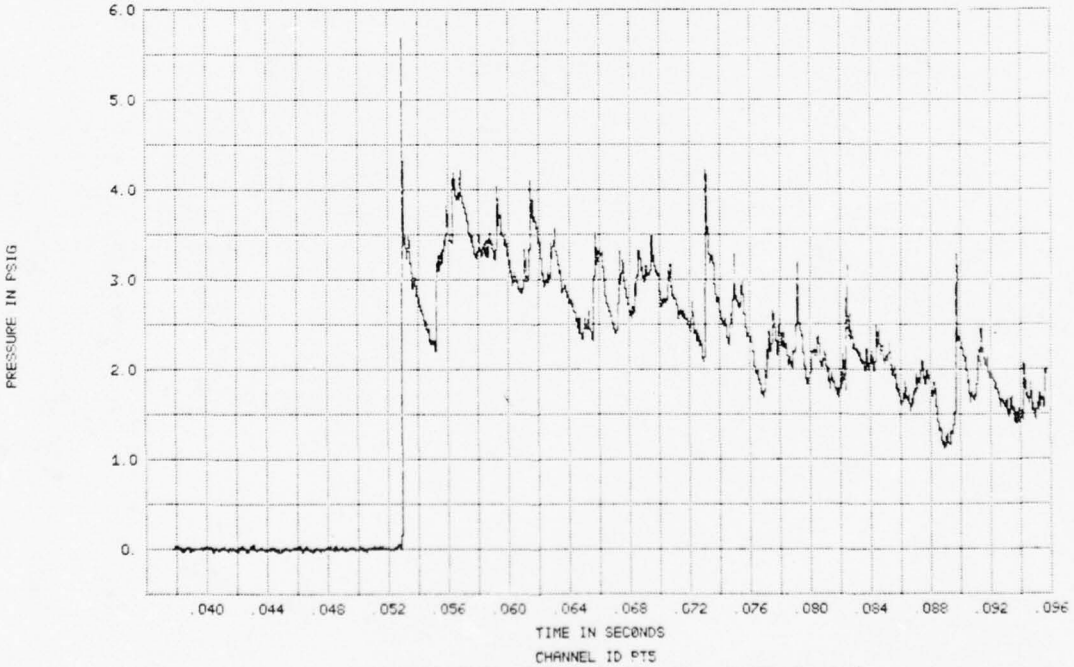


FIGURE 11-58 , SPECIMEN NO. 11 , SHOT NO. 4 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

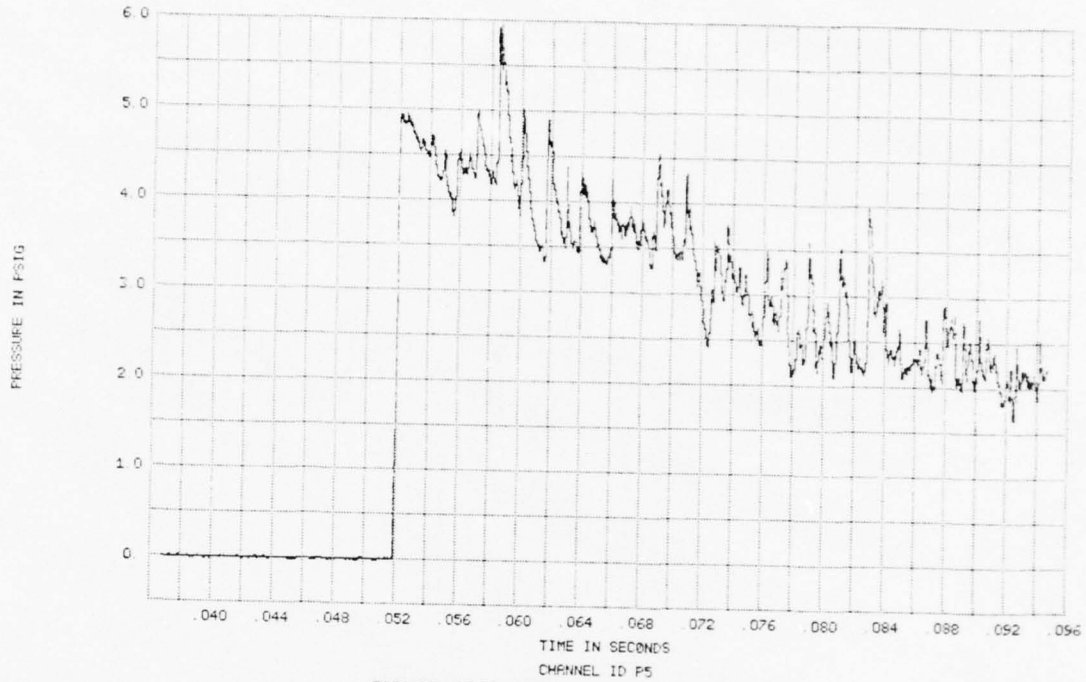


FIGURE 11-59 , SPECIMEN NO. 11 , SHOT NO. 5 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

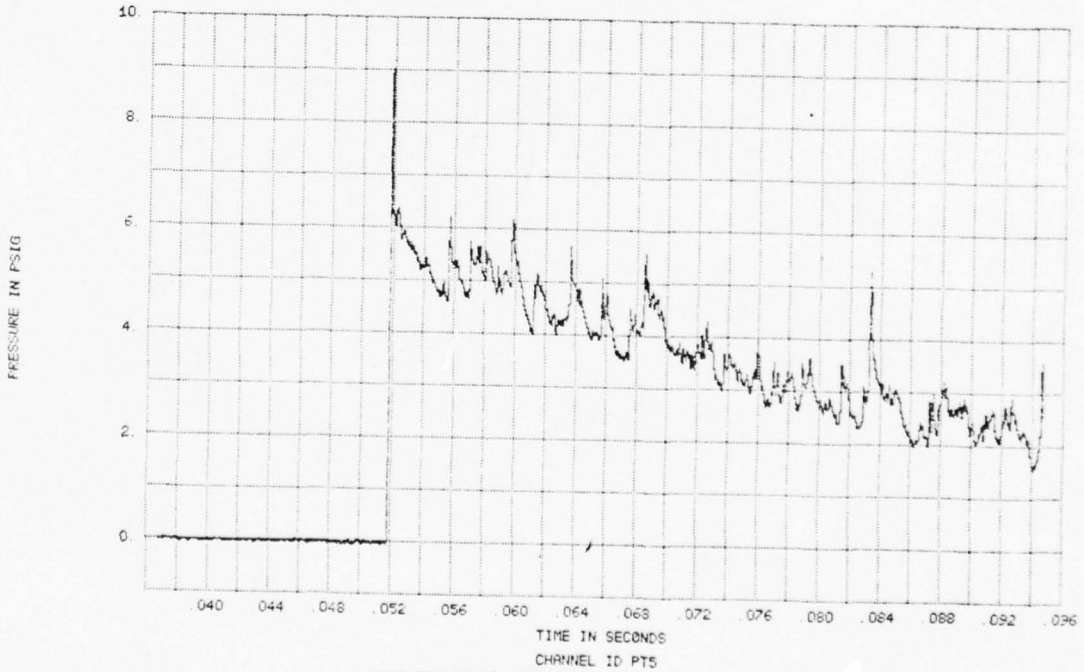


FIGURE 11-60 , SPECIMEN NO. 11 , SHOT NO. 5 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

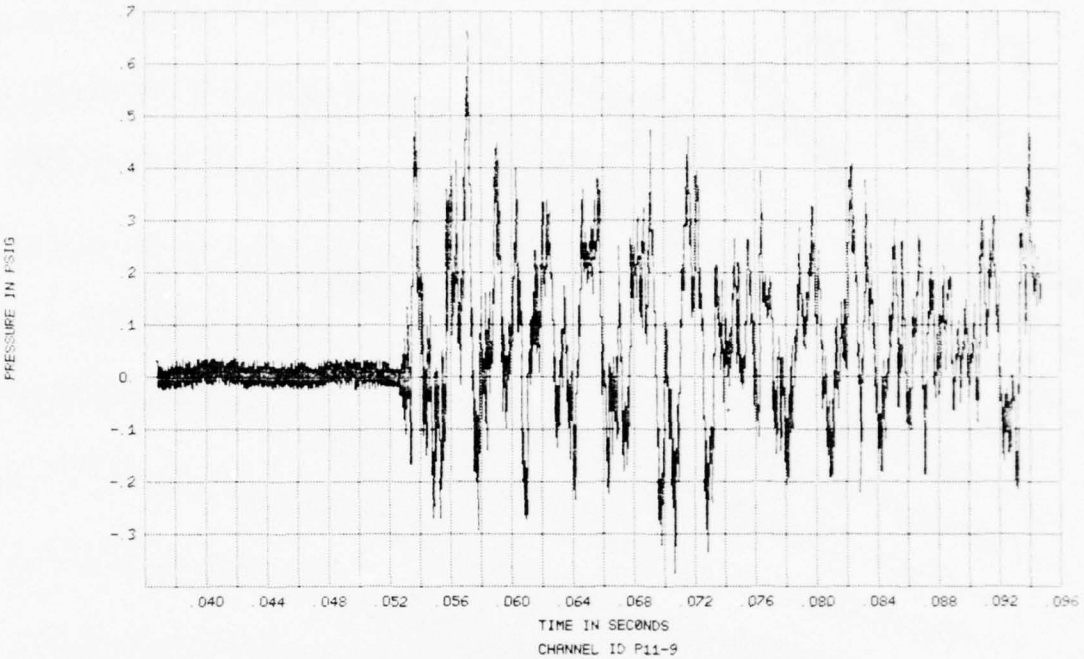


FIGURE 11-61 , SPECIMEN NO. 11 , SHOT NO. 5 ,
INTERNAL PRESSURE TIME HISTORY

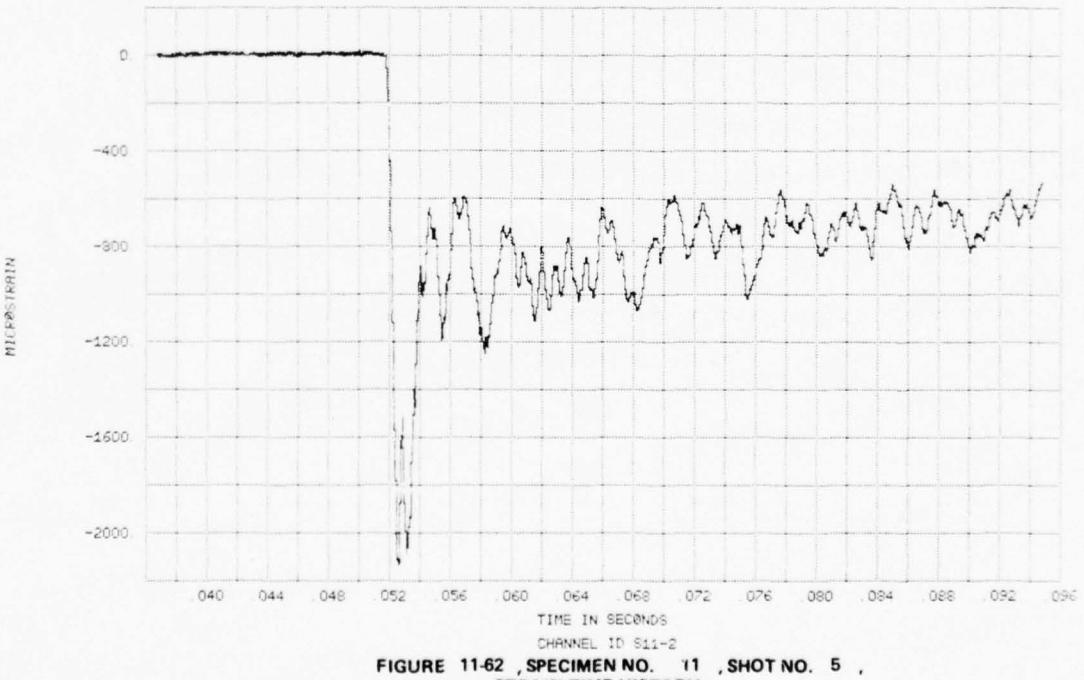


FIGURE 11-62 , SPECIMEN NO. 11 , SHOT NO. 5 ,
STRAIN TIME HISTORY

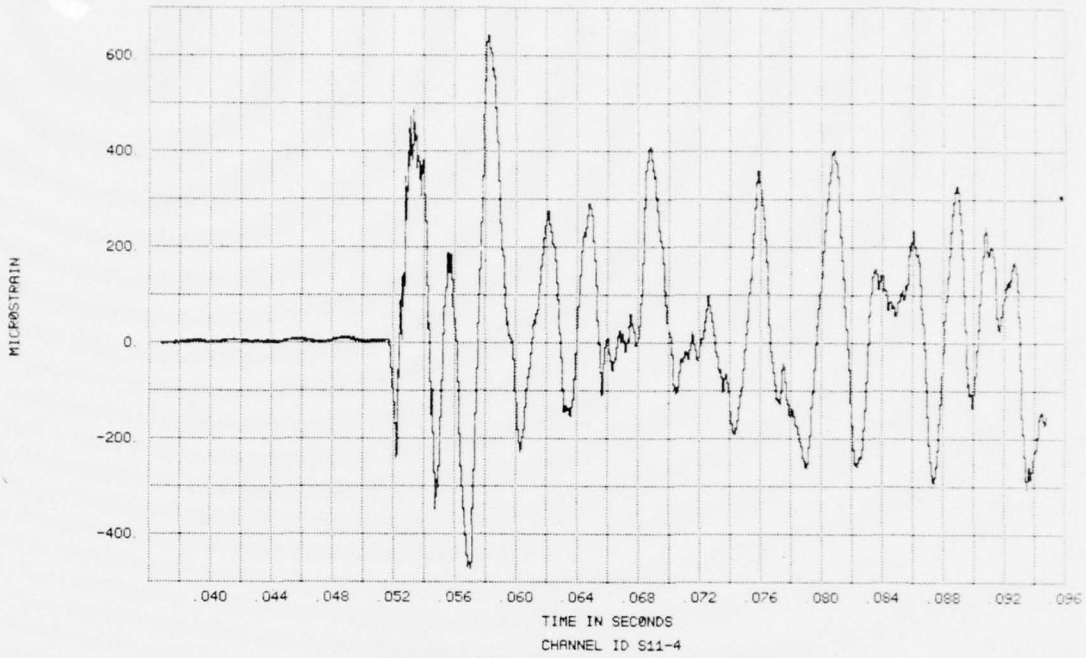


FIGURE 11-63 , SPECIMEN NO. 11 , SHOT NO. 5 , STRAIN TIME HISTORY

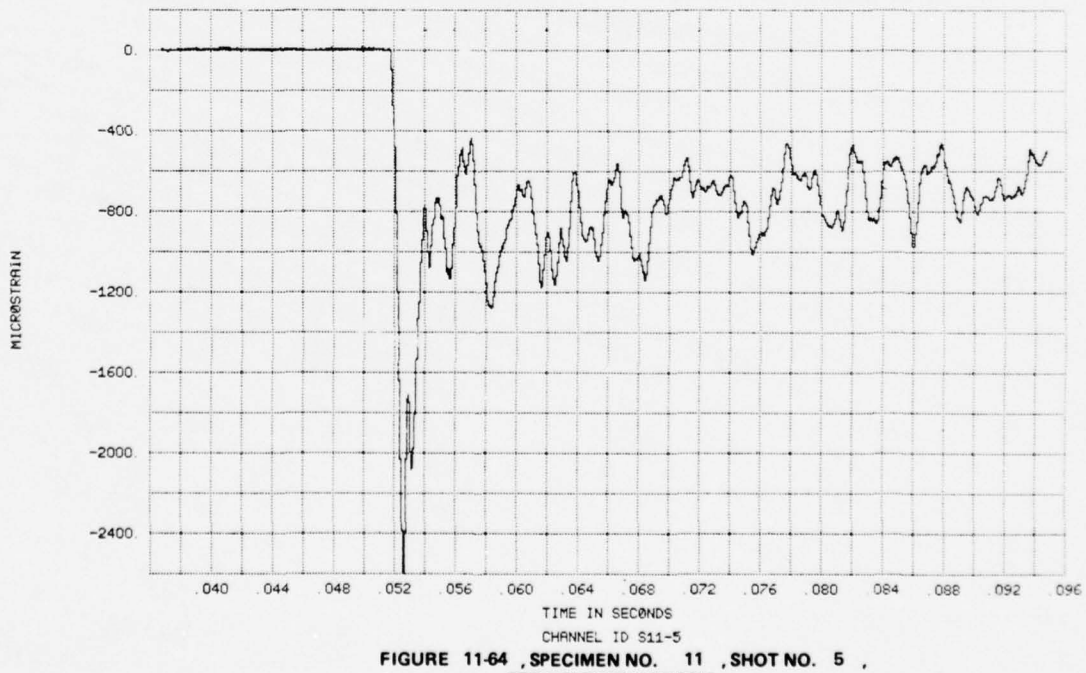
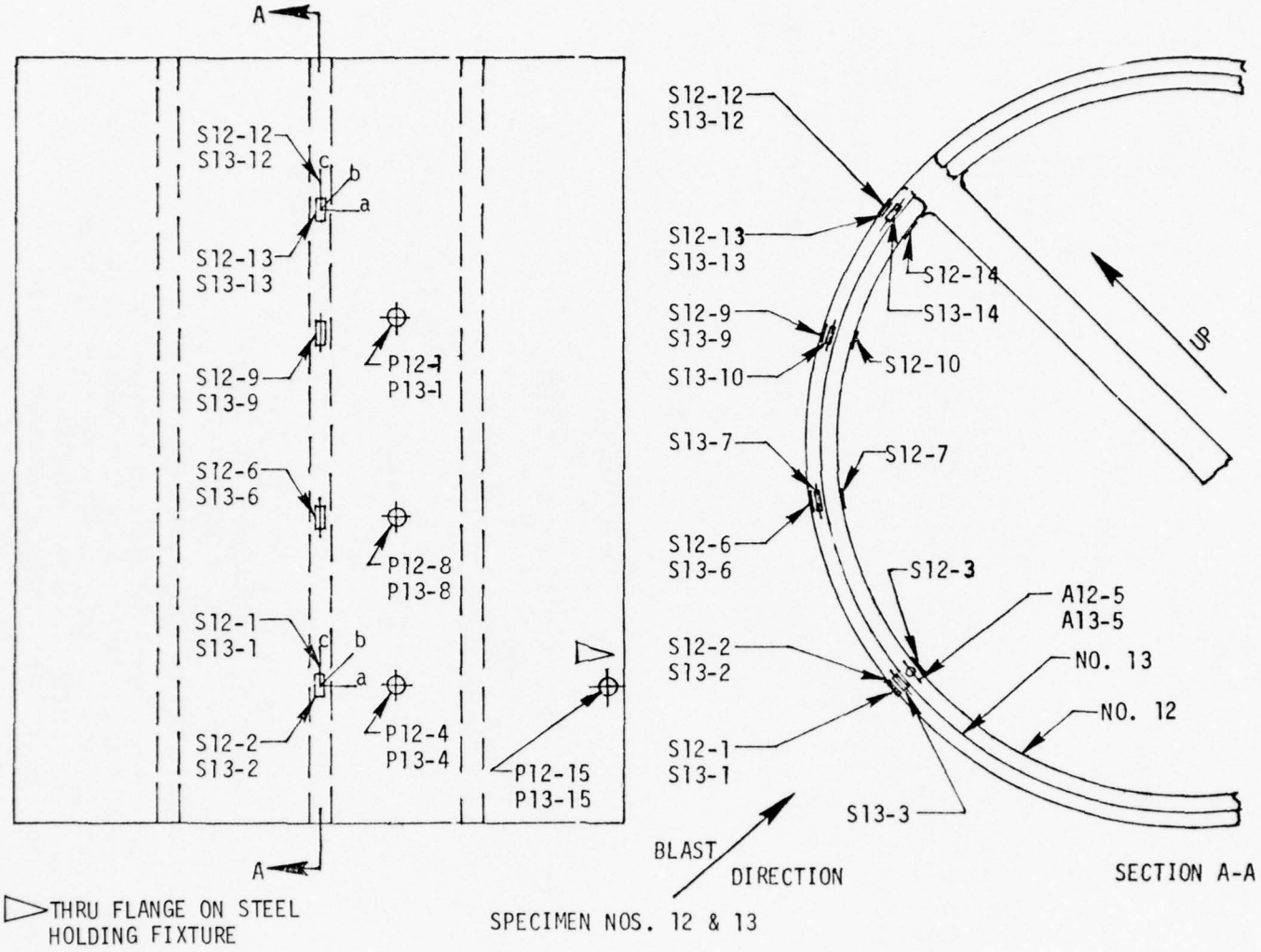


FIGURE 11-64 , SPECIMEN NO. 11 , SHOT NO. 5 , STRAIN TIME HISTORY



SPECIMEN NOS. 12 & 13

SPECIMEN NO. 12

SKIN/FRAME CYLINDER

FRAME CLAMPED AT TWO DIAMETRICALLY OPPOSITE POINTS

MATERIAL - 6061-T42 ALUMINUM ALLOY

DENSITY - .0002539 lb-sec^2/in^4 (MIL-HDBK-5)

POISSON'S RATIO - .33

MODULUS OF ELASTICITY - 10.3 x 10^6 PSI

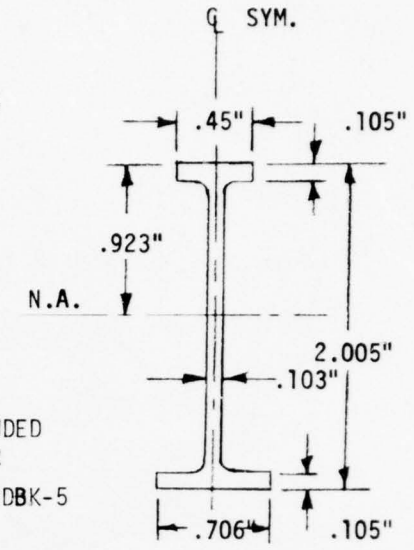
% ELONGATION - 25.0

F_{ty} - 19,460 PSI

F_{tu} - 37,900 PSI

THE SKIN WAS BONDED TO THE FRAME AND WAS NOT INCLUDED IN THE CROSS-SECTION DUE TO LACK OF SHEAR TRANSFER

STRESS/STRAIN DATA BASED ON COUPON TESTS AND MIL-HDBK-5



SECTION THRU FRAME

SPECIMEN NO. 13

SKIN/FRAME CYCLINDER

FRAME CLAMPED AT TWO DIAMETRICALLY OPPOSITE POINTS

MATERIAL - 6061-T42 ALUMINUM ALOOY

DENSITY - .0002539 lb-sec^2/in^4 (MIL-HDBK 5)

POISSON'S RATIO - .33

MODULUS OF ELASTICITY - 10.6 x 10^6 PSI

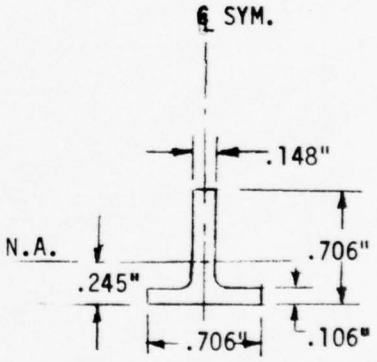
% ELONGATION - 25.5

F_{ty} - 20,800 PSI

F_{tu} - 36,690 PSI

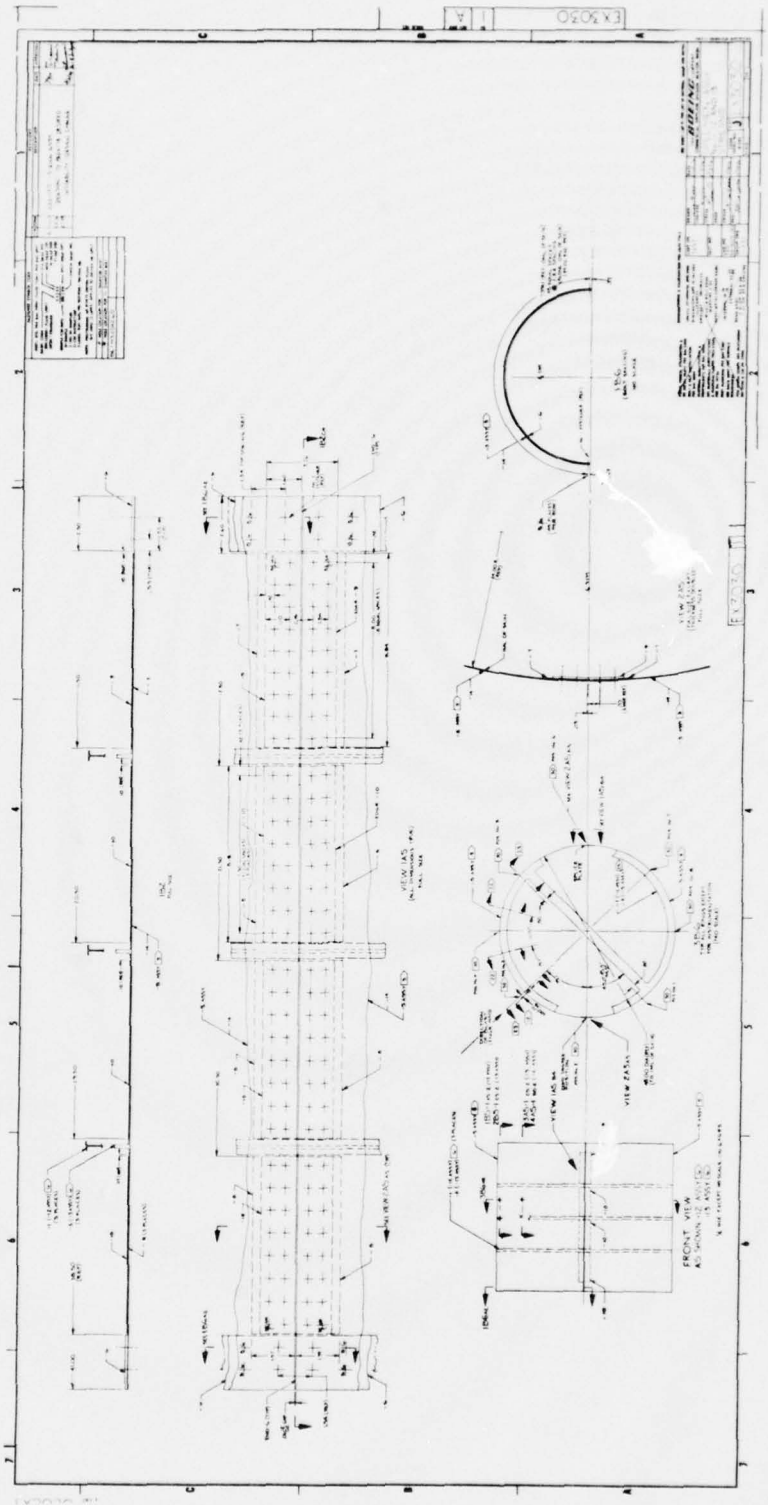
THE SKIN WAS BONDED TO THE FRAME AND WAS NOT INCLUDED IN THE CROSS-SECTION DUE TO LACK OF SHEAR TRANSFER

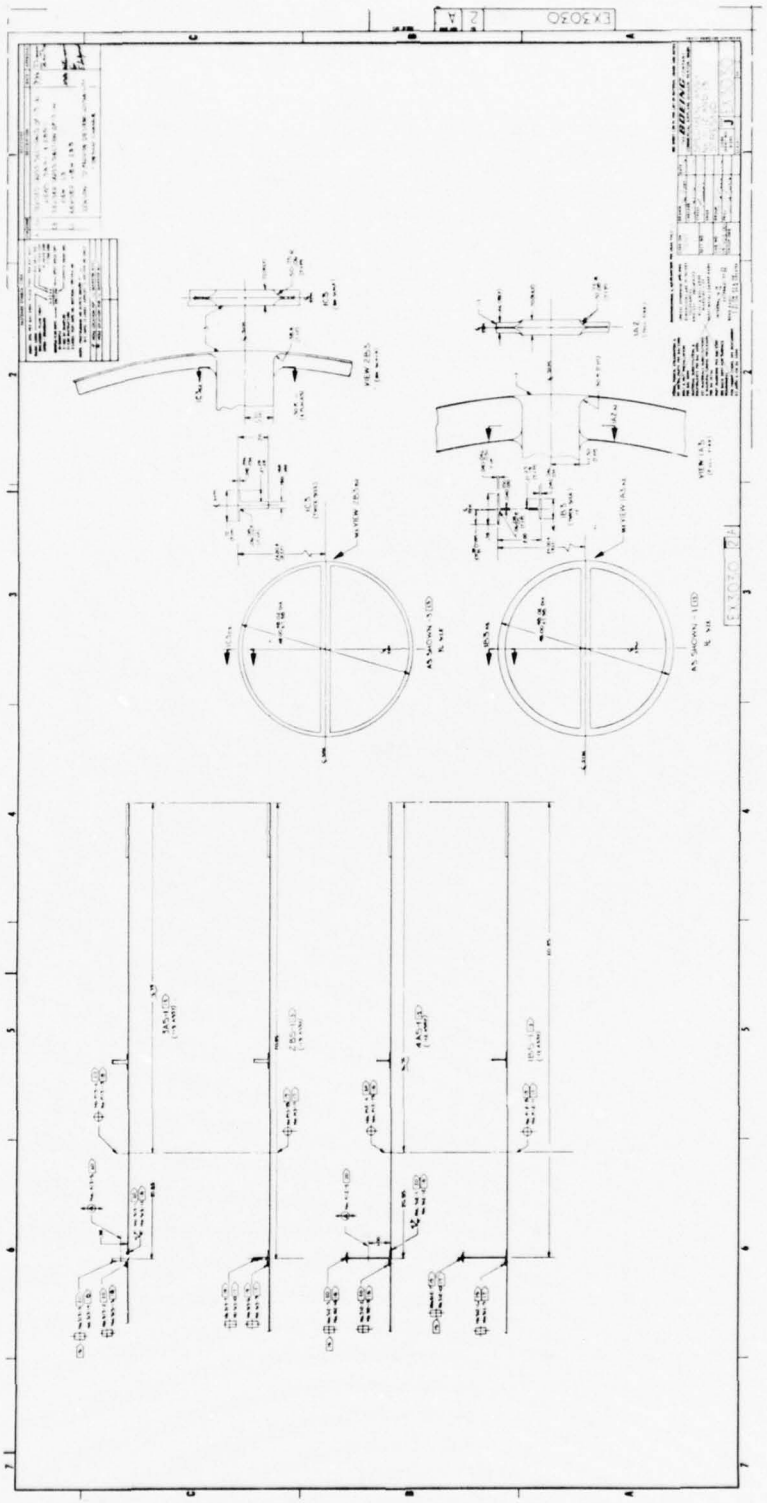
STRESS/STRAIN DATA BASED ON COUPON TESTS AND MIL-HDBK-5



SECTION THRU FRAME

This test specimen was tested and analyzed for symmetric loading (shock propagation vector perpendicular to the floor beam) as well as assymmetric loading (shock propagation vector at 45° with respect to floor beam). In addition, the test specimen was pressurized to 3 psi internal pressure for one symmetric load test shot and one assymmetric load test shot.





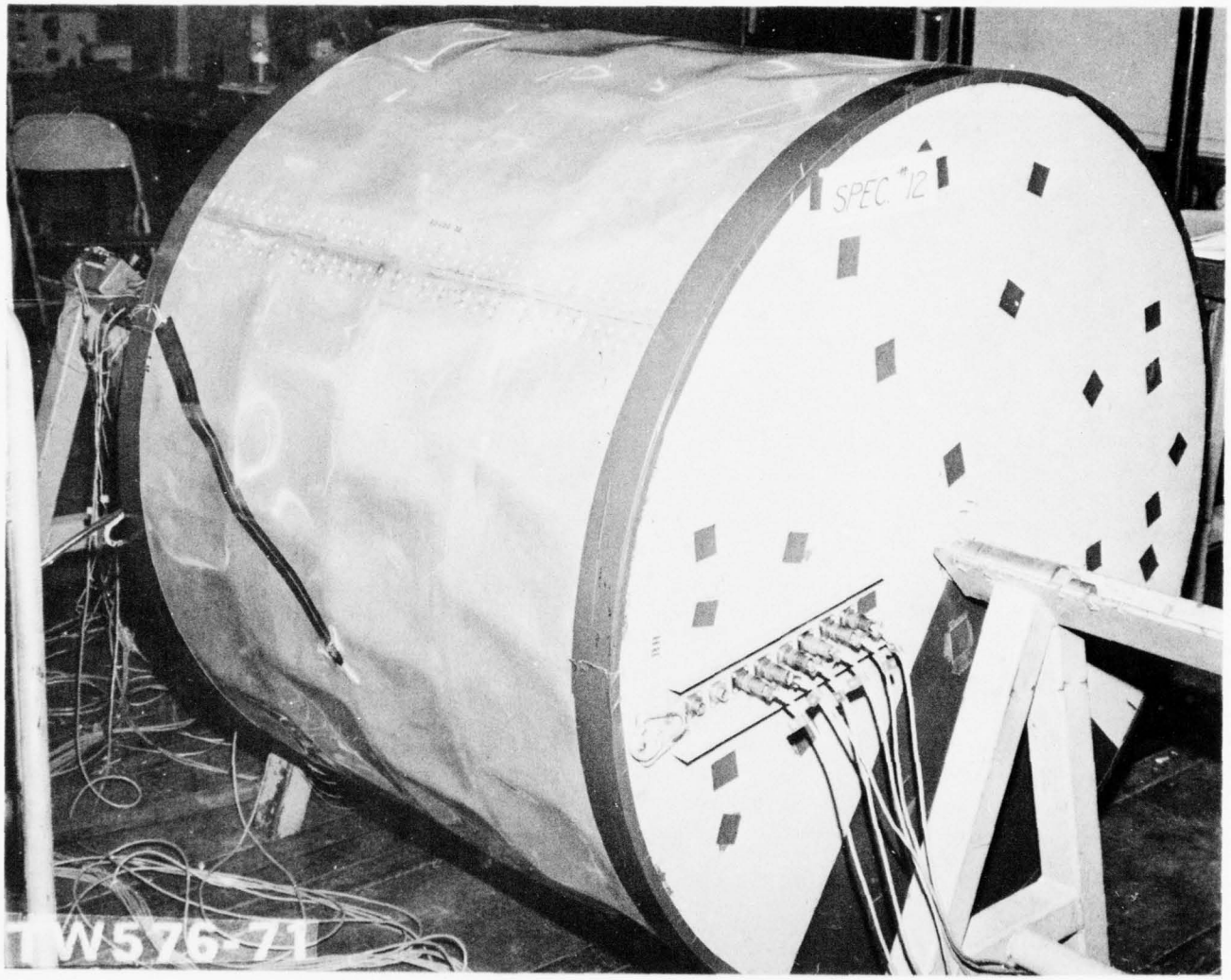


FIGURE 12-1 - SPECIMEN NO. 12 - TEST SET-UP - SKIN DEFORMED UNDER LOAD - DEFORMATION WAS NOT PERMANENT

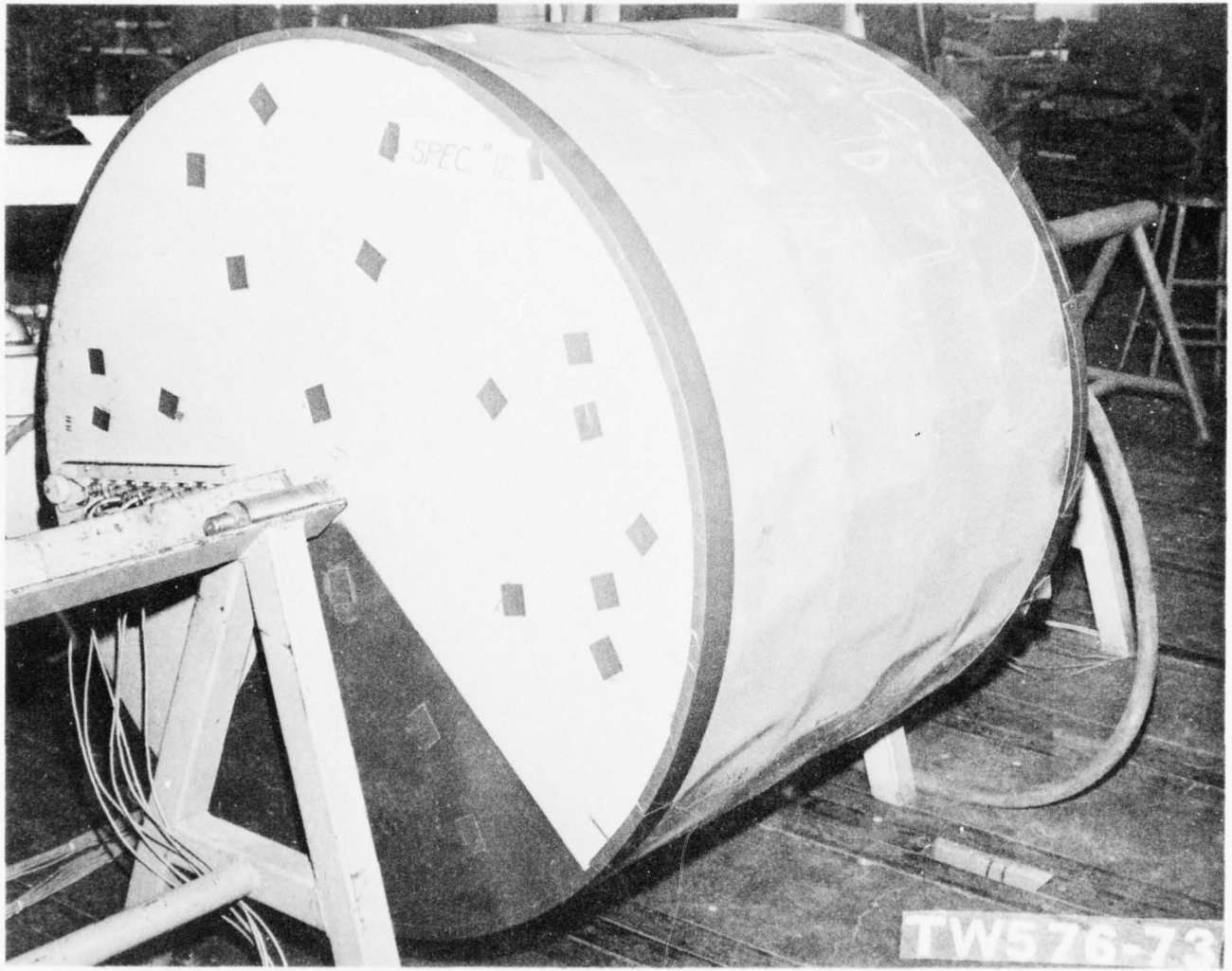


FIGURE 12-2 - SPECIMEN NO. 12 - TEST SET-UP - SKIN DEFORMED UNDER LOAD



FIGURE 12-3 - SPECIMEN NO. 12 - TEST SET-UP - SKIN DEFORMED UNDER LOAD

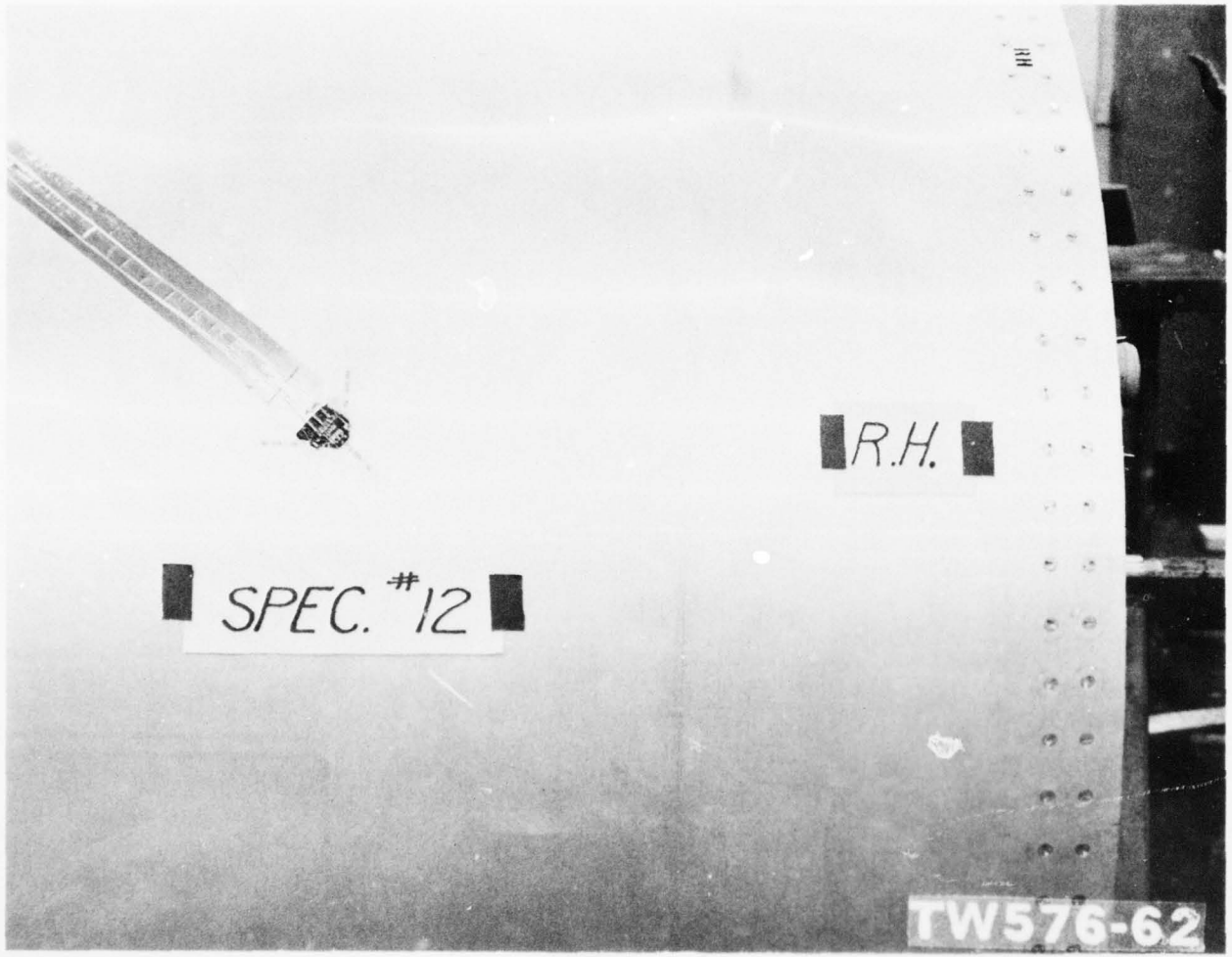


FIGURE 12-4 - SPECIMEN NO. 12 - FORWARD ROSETTE INSTALLATION

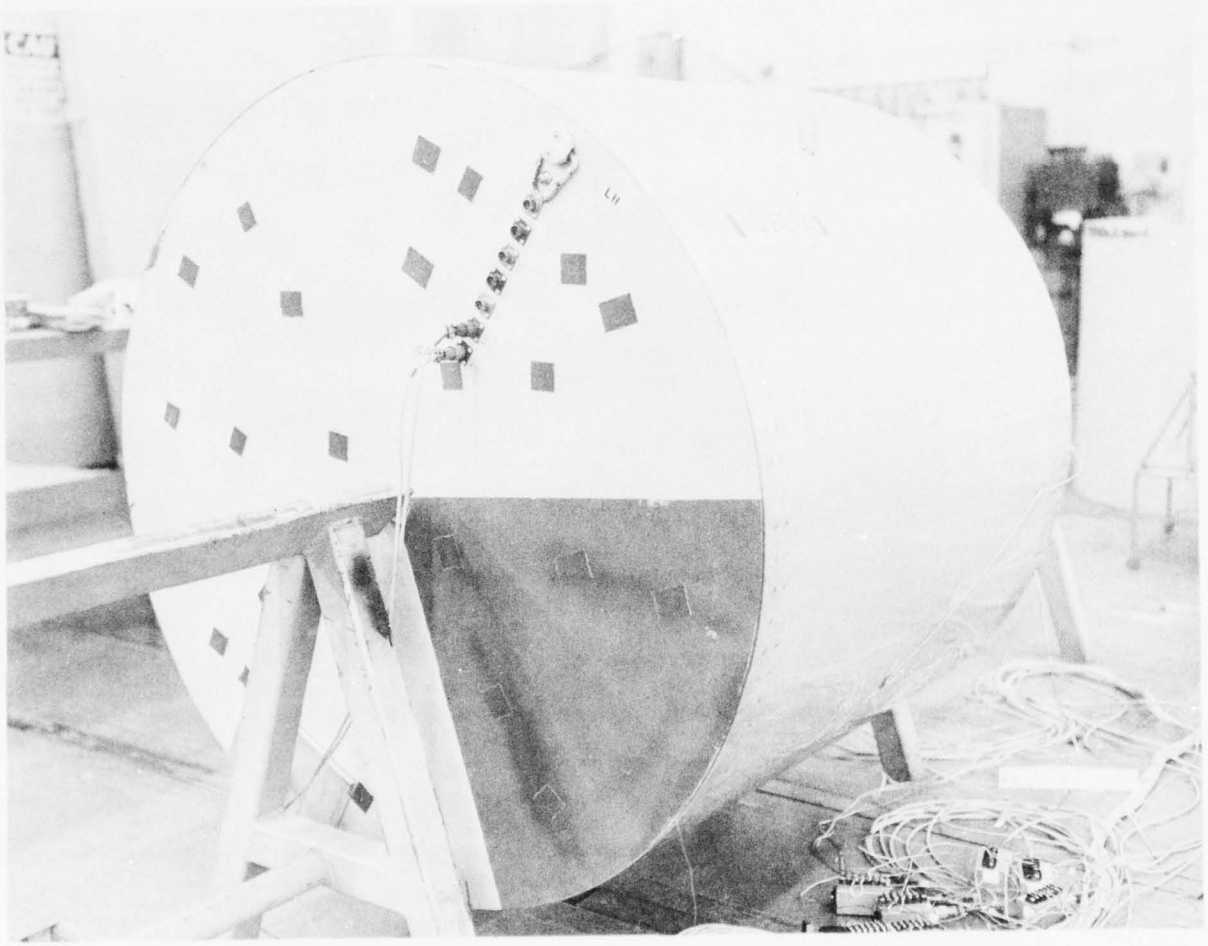


FIGURE 13-1 - SPECIMEN NO. 13 - TEST SET-UP

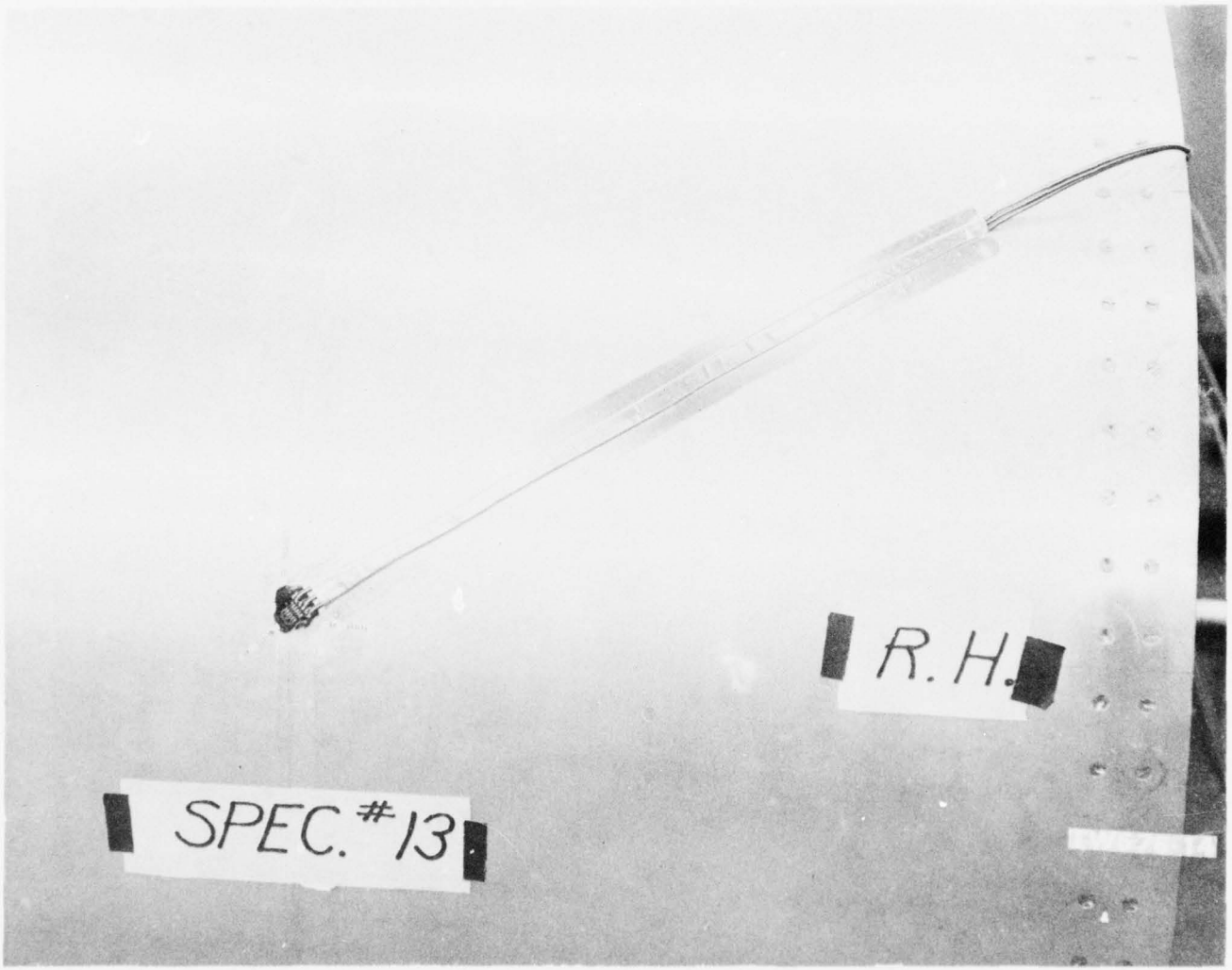


FIGURE 13-2 SPECIMEN NO. 13 - FORWARD ROSETTE INSTALLATION

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.12 - STATIC ANALYSIS - PRESS = 10. PSI - MAY'76 - SYRING  GP   1
          1           0                                                    GP   2
0.0        0.1         0.01        0.0                                     GP   3
0.0        0.0         0.0         0.0                                     GP   4
         15          15                                                    GP   5
100000.                                                                    GP   7
                                                                           GP   8
          2           0                                                    GP   9
          2                                                                GP  10
          0           0                                                    GP  12
          0           0                                                    GP  15
          0           0                                                    GP  18
          3                                                                GP  21
0.0       -36.0                                                            GP  22
0.0        0.0                                                             GP  23
0.0       24.0                                                             GP  24
-18.0     24.0                                                             GP  24
-36.0     24.0                                                             GP  24
          2           7                                                    GP  25
          2                                                                GP  27
0.0                                                                        GP  29
-10.                                                                       GP  30
          1           2           2           1           1                GPB   1
         32           3           4                                        GPB   2
23.0                                                                       GPB   3
0.0        3.14159                                                         GPB   4
          0                                                                GPB   5
          1           1           1                                        GPB  12
.0002539   .0002539    .0002539                                            GPB  13
9.0                                                                        GPB  14
0.105                                                                      GPB  15
0.706                                                                      GPB  16
          3                                                                GPB  17
.00191     19670.                                                          GPB  18
.0029      20000.                                                          GPB  19
.0059      21500.                                                          GPB  18
          3                                                                GPB  19
.00191     19670.                                                          GPB  20
.0029      20000.                                                          GPB  20
.0059      21500.                                                          GPB  20
1.795                                                                      GPB  15
.103                                                                       GPB  16
          3                                                                GPB  17
.00191     19670.                                                          GPB  18
.0029      20000.                                                          GPB  19
.0059      21500.                                                          GPB  18
          3                                                                GPB  19
.00191     19670.                                                          GPB  20
.0029      20000.                                                          GPB  20
.0059      21500.                                                          GPB  20
0.105                                                                      GPB  15
0.457                                                                      GPB  16
          3                                                                GPB  17
.00191     19670.                                                          GPB  18
.0029      20000.                                                          GPB  19
.0059      21500.                                                          GPB  18
          3                                                                GPB  19
.00191     19670.                                                          GPB  20
.0029      20000.                                                          GPB  20
.0059      21500.                                                          GPB  20
.000001    .000001     1.0                                                 GPB  22
                                                                           GP   32
```

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.13 - STATIC ANALYSIS - PRESS = 8.0 PSI - MAY'76 - SYRING  GP  1
          1             0                                                  GP  2
0.0        0.1           0.01         0.0                                  GP  3
0.0        0.0           0.0          0.0                                  GP  4
         15            15                                                  GP  5
100000.                                                                    GP  7
                                                                           GP  8
          2             0                                                  GP  9
          2                                                                GP 10
          0             0                                                  GP 12
          0             0                                                  GP 15
          0             0                                                  GP 18
          3                                                                GP 21
0.0        -36.0                                                           GP 22
0.0        0.0                                                             GP 23
0.0        24.0                                                            GP 24
-18.0      24.0                                                            GP 24
-36.0      24.0                                                            GP 24
          2             7                                                  GP 25
          2                                                                GP 27
0.0                                                                        GP 29
-8.0                                                                       GP 30
          1             2             2            1            1         GPB  1
         32             2             4                                    GPB  2
23.645                                                                     GPB  3
0.0        3.14159                                                         GPB  4
          0                                                                GPB  5
          1             1                                                  GPB 12
.0002539   .0002539                                                        GPB 13
9.0                                                                        GPB 14
0.106                                                                      GPB 15
0.705                                                                      GPB 16
          3                                                                GPB 17
.00196     20800.                                                          GPB 18
.0029      21000.                                                          GPB 18
.0059      21500.                                                          GPB 18
          3                                                                GPB 19
.00196     20800.                                                          GPB 20
.0029      21000.                                                          GPB 18
.0059      21500.                                                          GPB 20
0.602                                                                      GPB 15
0.148                                                                      GPB 16
          3                                                                GPB 17
.00196     20800.                                                          GPB 18
.0029      21000.                                                          GPB 18
.0059      21500.                                                          GPB 18
          3                                                                GPB 19
.00196     20800.                                                          GPB 20
.0029      21000.                                                          GPB 20
.0059      21500.                                                          GPB 20
.000001    .000001     1.0                                                 GPB 22
                                                                           GP 32
```

TABLE XLI

STATIC TEST STRESSES - SPECIMEN NO. 12
(STRESSES GIVEN IN PSI)

STRAIN GAUGE	STATIC PRESSURE (PSI)		
	1.2	2.4	3.6
S12-1	3109.	3442.	-2605.
S12-2	-2987.	-5675.	-8724.
S12-3	-721.	-999.	-1803.
S12-6	1195.	2050.	2606.
S12-7	927.	2173.	1092.
S12-9	-2627.	-7385.	-8013.
S12-10	1298.	1360.	-31.
S12-12	3037.	-6478.	33971.
S12-13	5026.	6571.	4192.
S12-14	-1916.	-4275.	-5675.

TABLE XLII

STATIC TEST STRESSES - SPECIMEN NO. 13
(STRESSES GIVEN IN PSI)

STRAIN GAUGE	STATIC PRESSURE (PSI)		
	1.2	2.4	3.6
S13-1	2524.	9190.	24881.
S13-2	-1802.	-3848.	-7452.
S13-3	1145.	1760.	647.
S13-6	-636.	816.	3774.
S13-7	-2290.	-3816.	-3922.
S13-9	-1367.	-6265.	-11480.
S13-10	1654.	1336.	-106.
S13-12	3980.	8794.	15717.
S13-13	795.	-2258.	-3286.
S13-14	-3540.	-5364.	-7494.

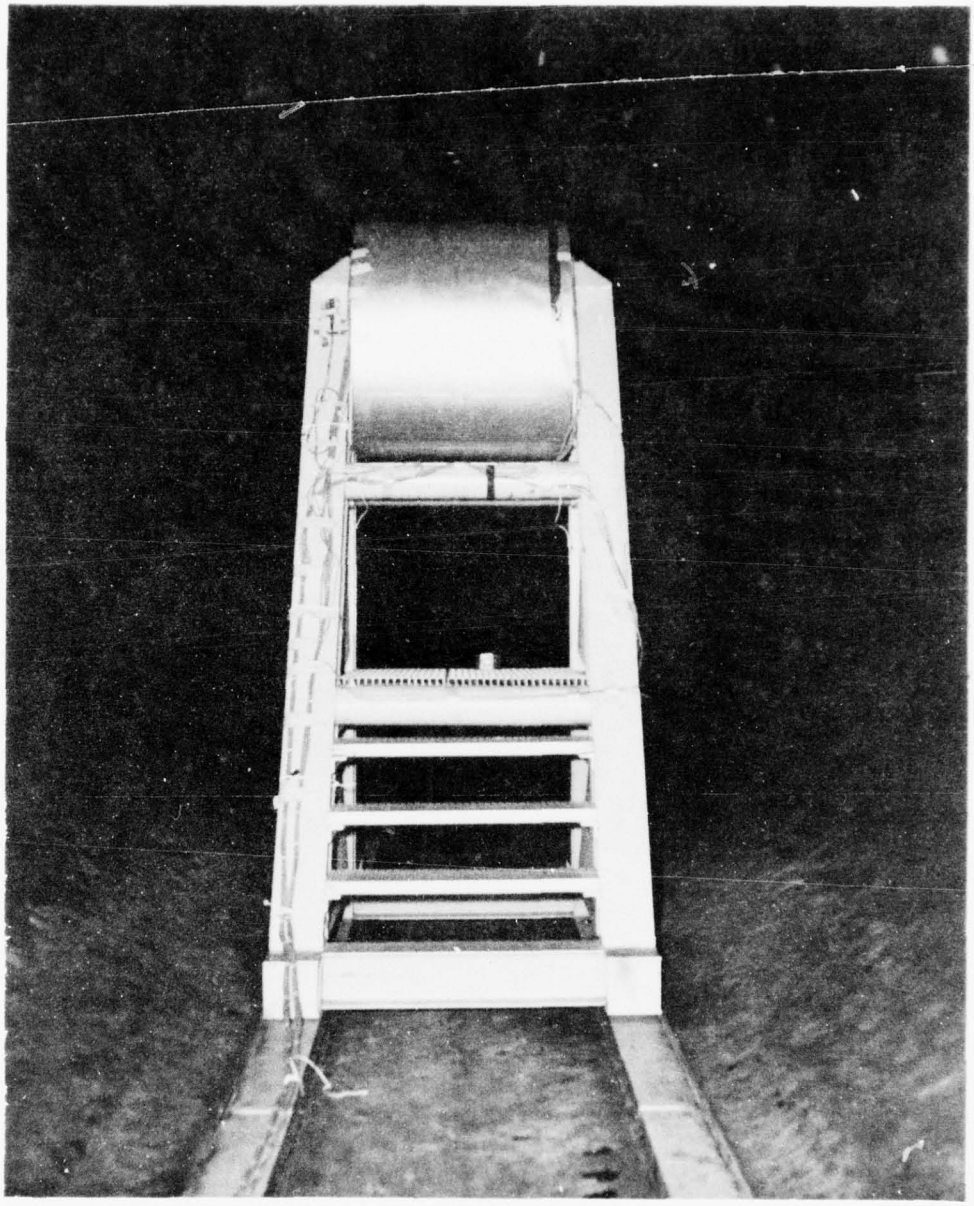


FIGURE 12-5 - SPECIMEN NO. 12 - SHOCK TEST SET-UP - VIEW FROM REAR

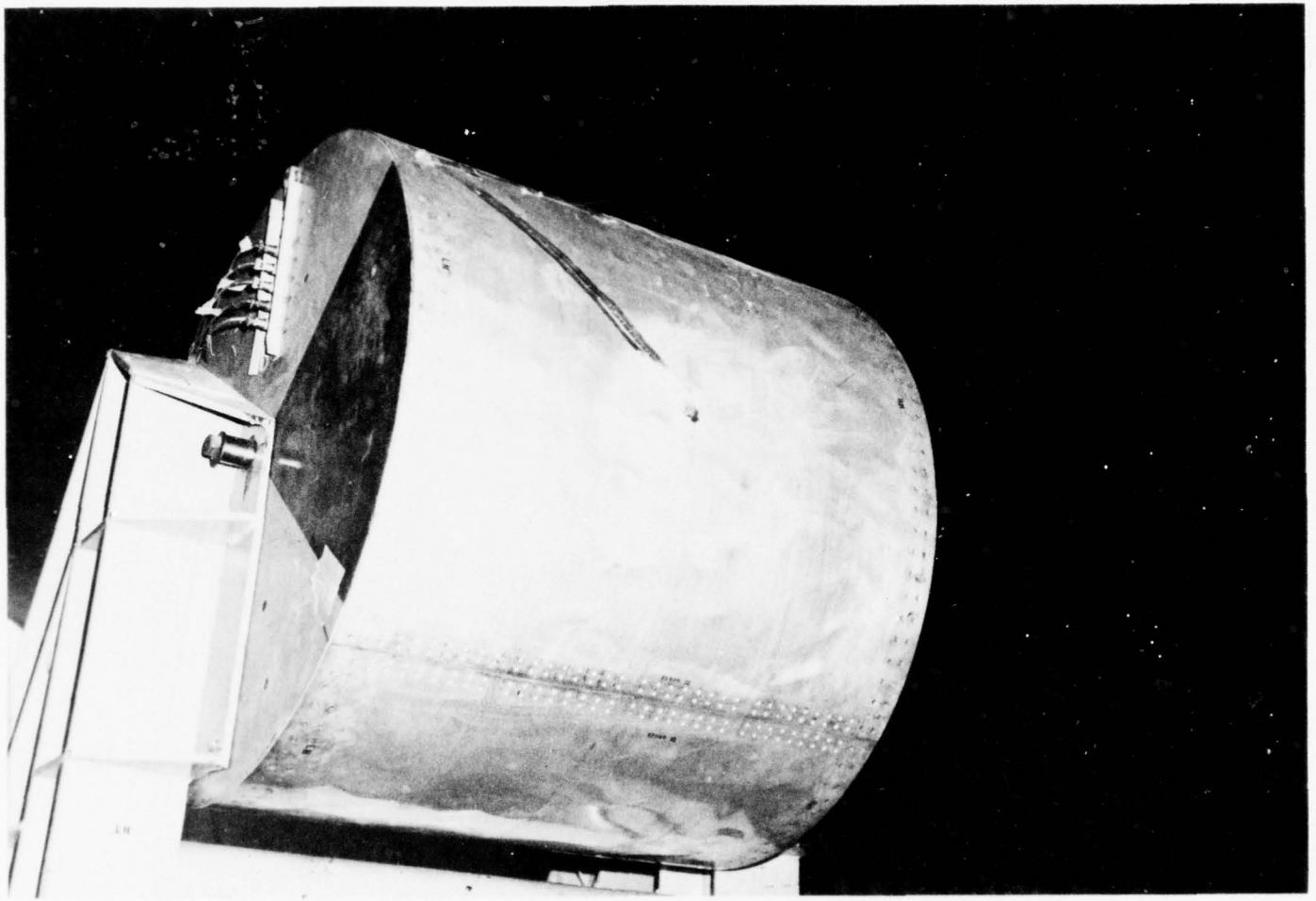


FIGURE 12-6 - SPECIMEN NO. 12 - SKIN WRINKLES AFTER THIRD SHOT

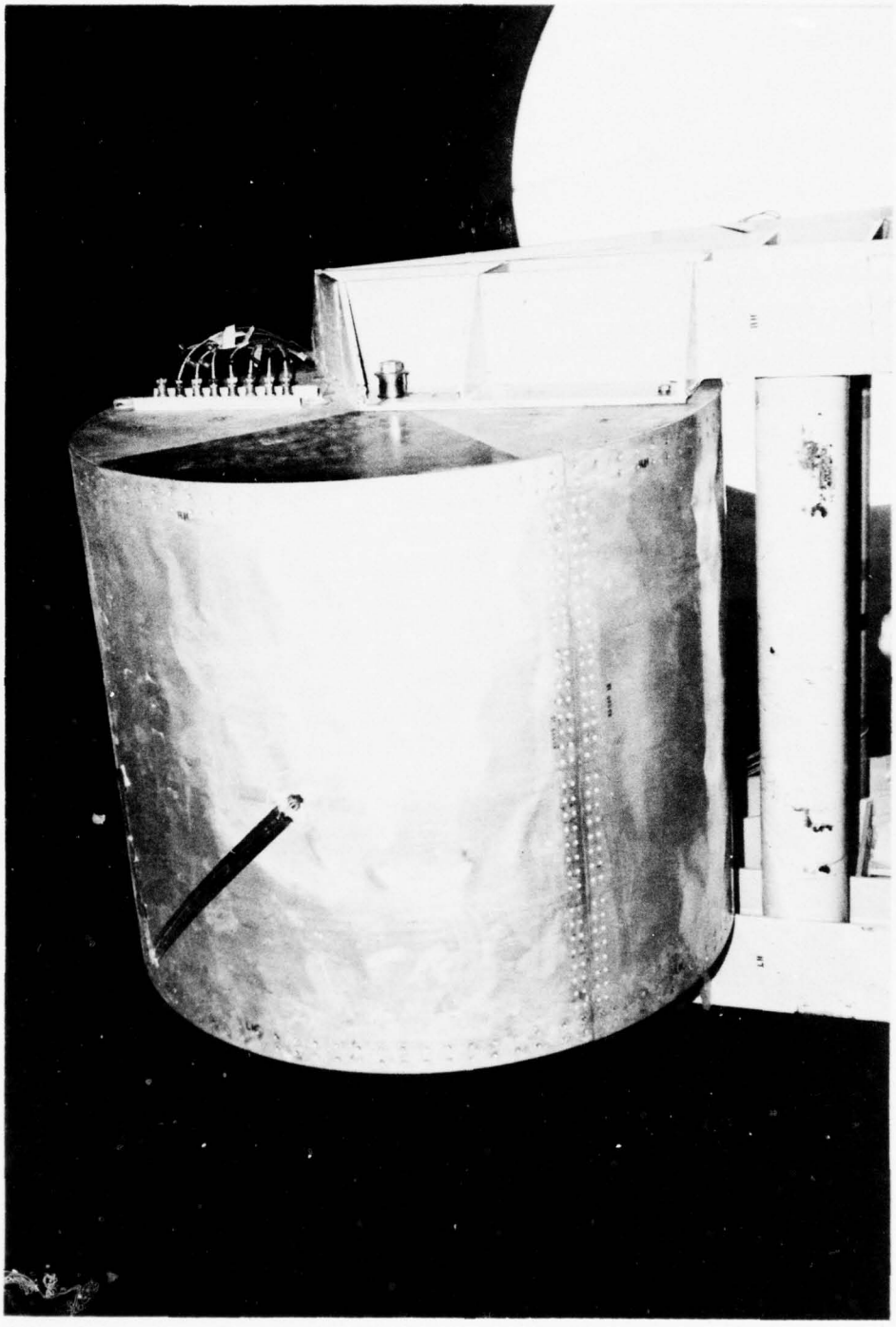


FIGURE 12-7 - SPECIMEN NO. 12 - SKIN WRINKLES AFTER THIRD SHOT

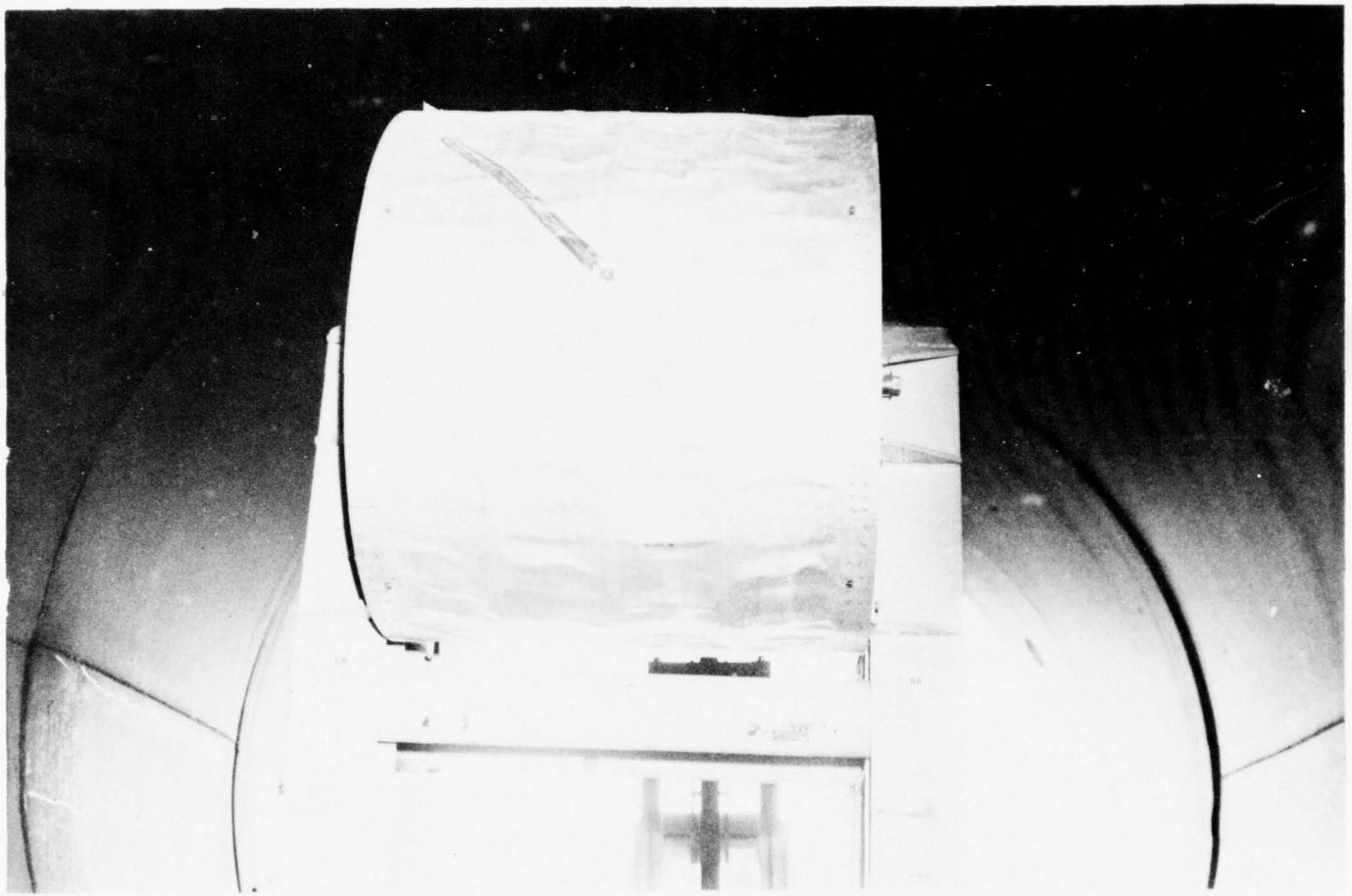


FIGURE 12-8 - SPECIMEN NO. 12 - SKIN WRINKLES AFTER FINAL SHOT

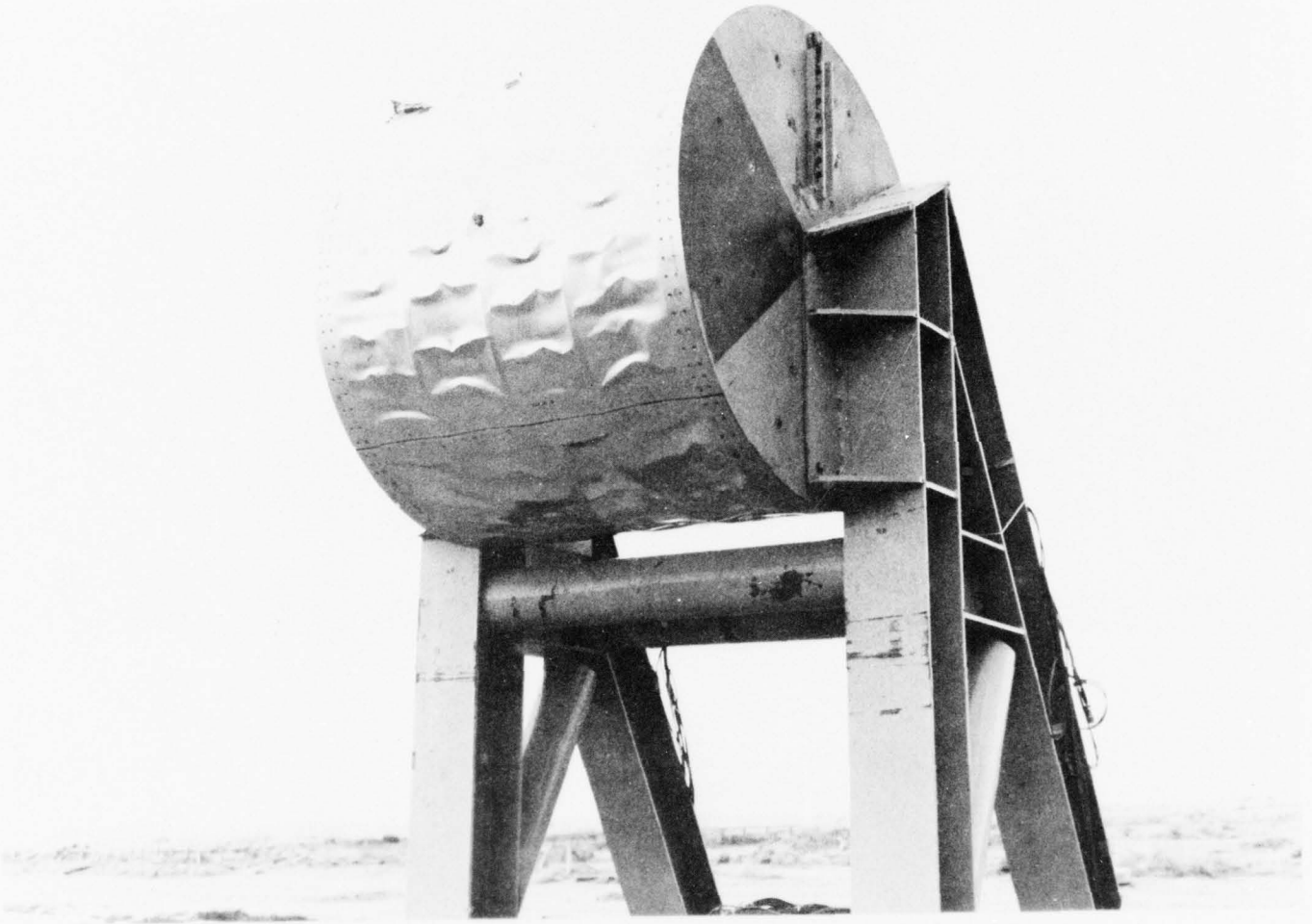


FIGURE 12-9 - SPECIMEN NO. 12 - SKIN WRINKLES AFTER FINAL SHOT

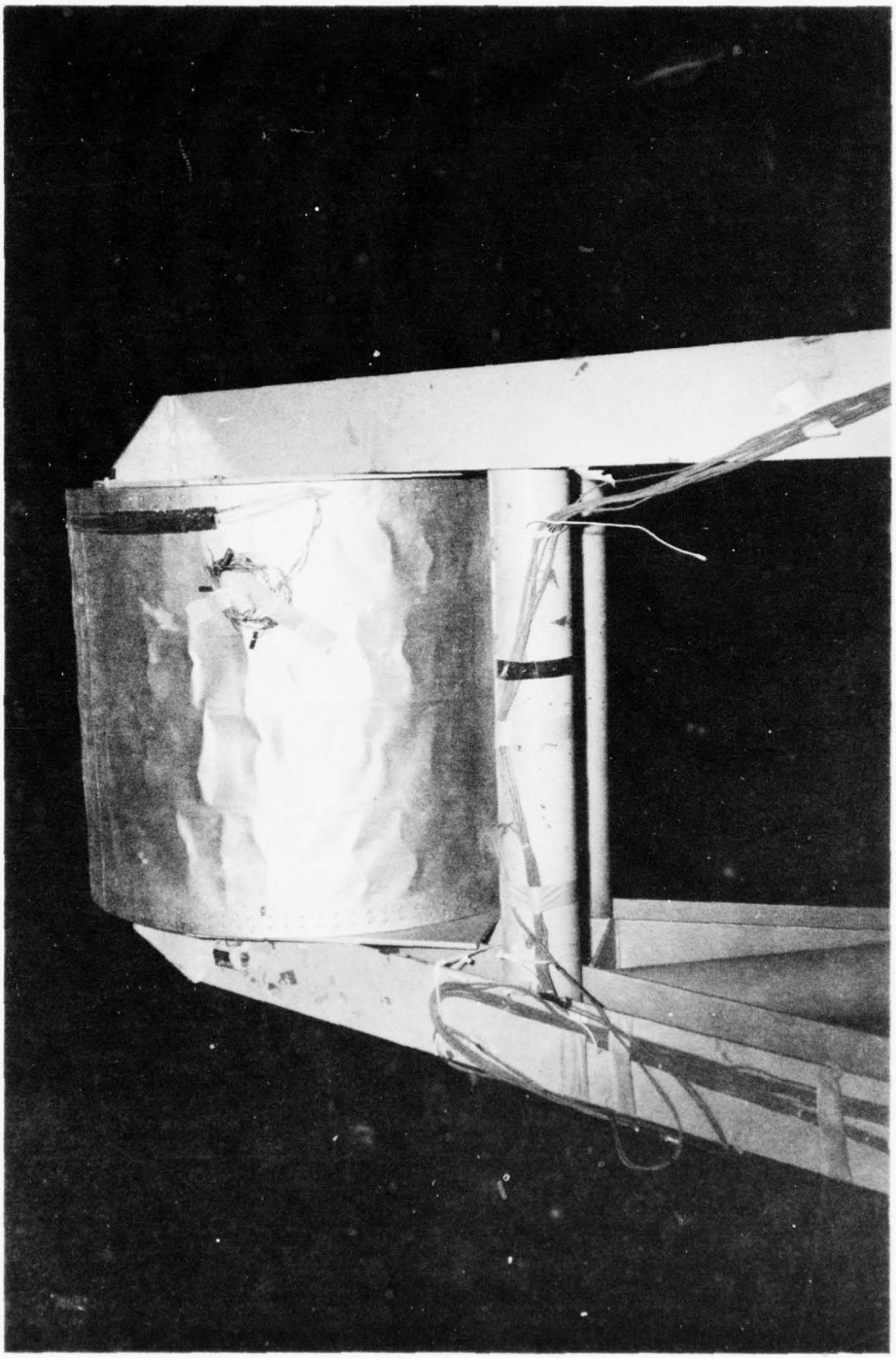


FIGURE 12-10 - SPECIMEN NO. 12 - SKIN WRINKLES AFTER FINAL SHOT - VIEW FROM REAR

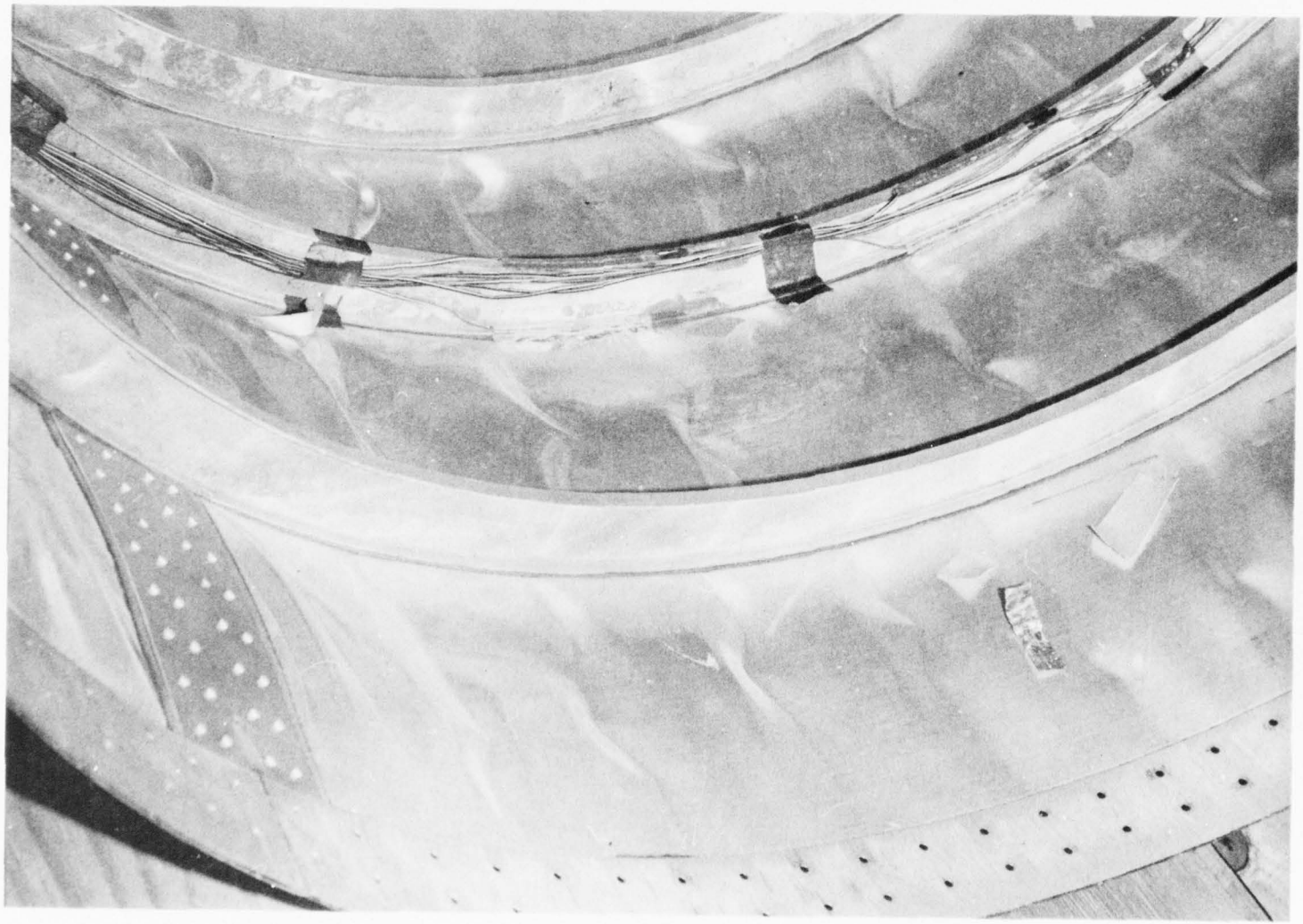


FIGURE 12-11 - SPECIMEN NO. 12 - INSIDE OF SPECIMEN - NO VISIBLE FRAME DAMAGE

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO. 12 - DYNAMIC ANALYSIS - ITERATIVE TPO SOLUTION                GP  1
          1              0                                                      GP  2
5000.       0.001         0.02          0.0                                    GP  3
0.0         0.0           0.0           0.0                                    GP  4
         15             15                                                     GP  5
350.0                                                                          GP  7
                                                                               GP  8
          2              0                                                      GP  9
          0              1                                                      GP 10
0.5                                                                            GP 11
          0              0                                                      GP 12
          0              0                                                      GP 15
          0              0                                                      GP 18
          3                                                                     GP 21
0.0        -36.0                                                               GP 22
0.0         0.0                                                                GP 23
0.0        24.0                                                                GP 24
-18.0      24.0                                                                GP 24
-36.0      24.0                                                                GP 24
          2              7                                                      GP 25
          2                                                                     GP 27
0.0                                                                            GP 29
0.0                                                                            GP 30
          1              2             2             1             1          1 GPB  1
         32              3             4                                      GPB  2
23.0                                                                           GPB  3
0.0         3.14159                                                            GPB  4
          0                                                                    GPB  8
          1              1             1                                      GPB 12
.0002539    .0002539      .0002539                                           GPB 13
9.0                                                                            GPB 14
0.105                                                                          GPB 15
0.706                                                                          GPB 16
          3                                                                    GPB 17
.00191      19670.                                                           GPB 18
.0059       21500.                                                           GPB 18
.25         37900.0                                                          GPB 18
          3                                                                    GPB 19
.00191      19670.                                                           GPB 20
.0059       21500.                                                           GPB 20
0.25        37900.                                                           GPB 20
1.795                                                                          GPB 15
.103                                                                           GPB 16
          3                                                                    GPB 17
.00191      19670.                                                           GPB 18
.0059       21500.                                                           GPB 18
.25         37900.0                                                          GPB 18
          3                                                                    GPB 19
.00191      19670.                                                           GPB 20
.0059       21500.                                                           GPB 20
0.25        37900.                                                           GPB 20
0.105                                                                          GPB 15
0.457                                                                          GPB 16
          3                                                                    GPB 17
.00191      19670.                                                           GPB 18
.0059       21500.                                                           GPB 18
.25         37900.0                                                          GPB 18
          3                                                                    GPB 19
.00191      19670.                                                           GPB 20
.0059       21500.                                                           GPB 20
0.25        37900.                                                           GPB 20
0.1     E-050.00333      25.0                                                GPB 22
                                                                               GP 32
```

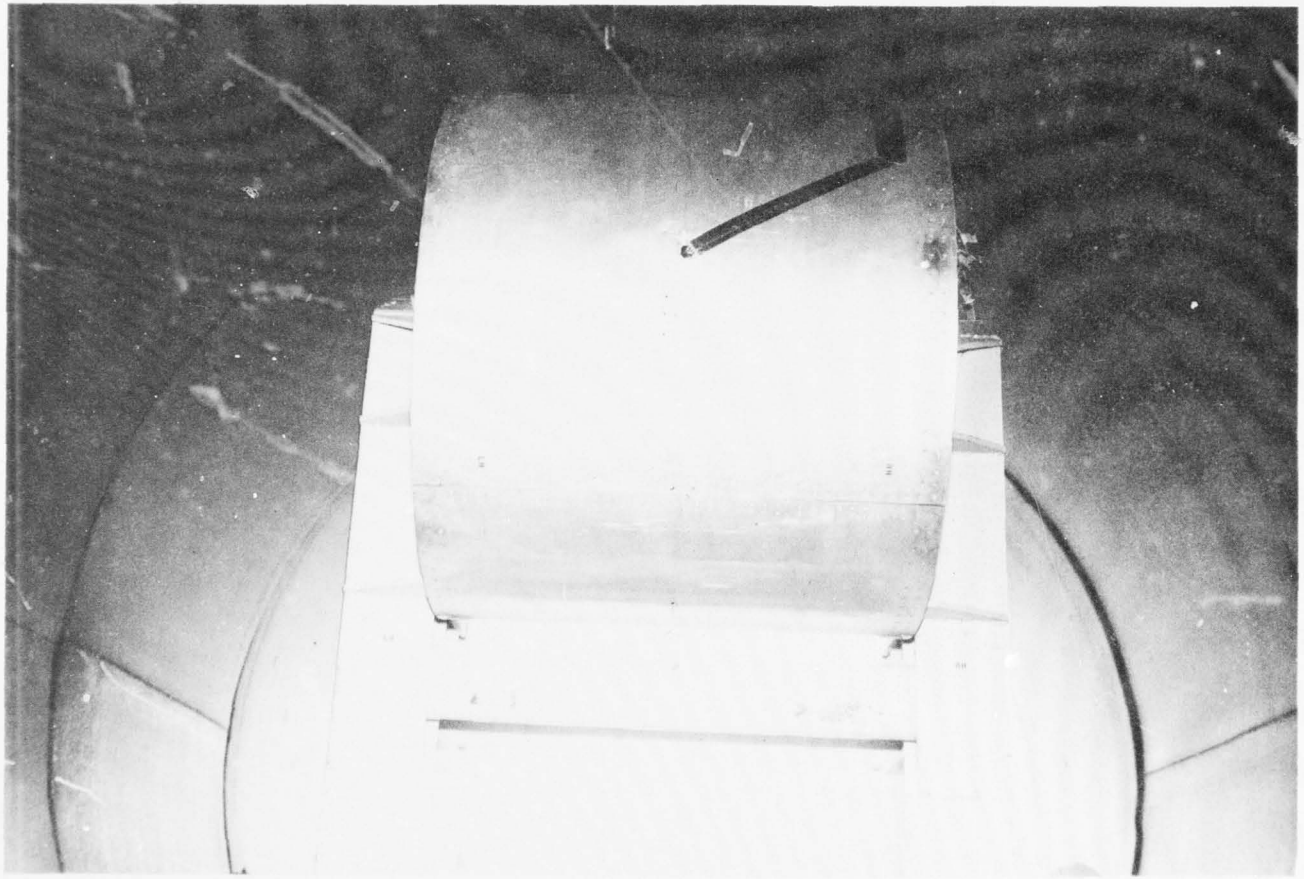


FIGURE 13-3 - SPECIMEN NO. 13 - SHOCK TEST SET-UP - FRONT VIEW

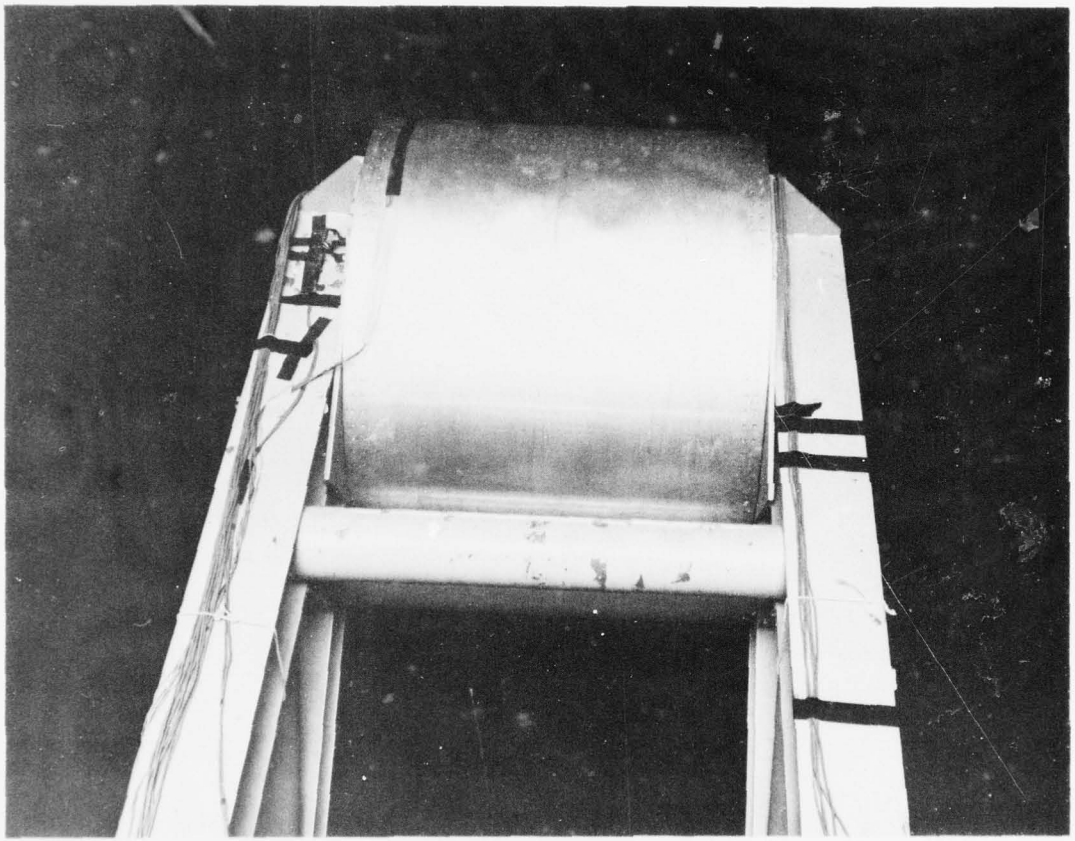


FIGURE 13-4 - SPECIMEN NO. 13 - SHOCK TEST SET-UP -REAR VIEW

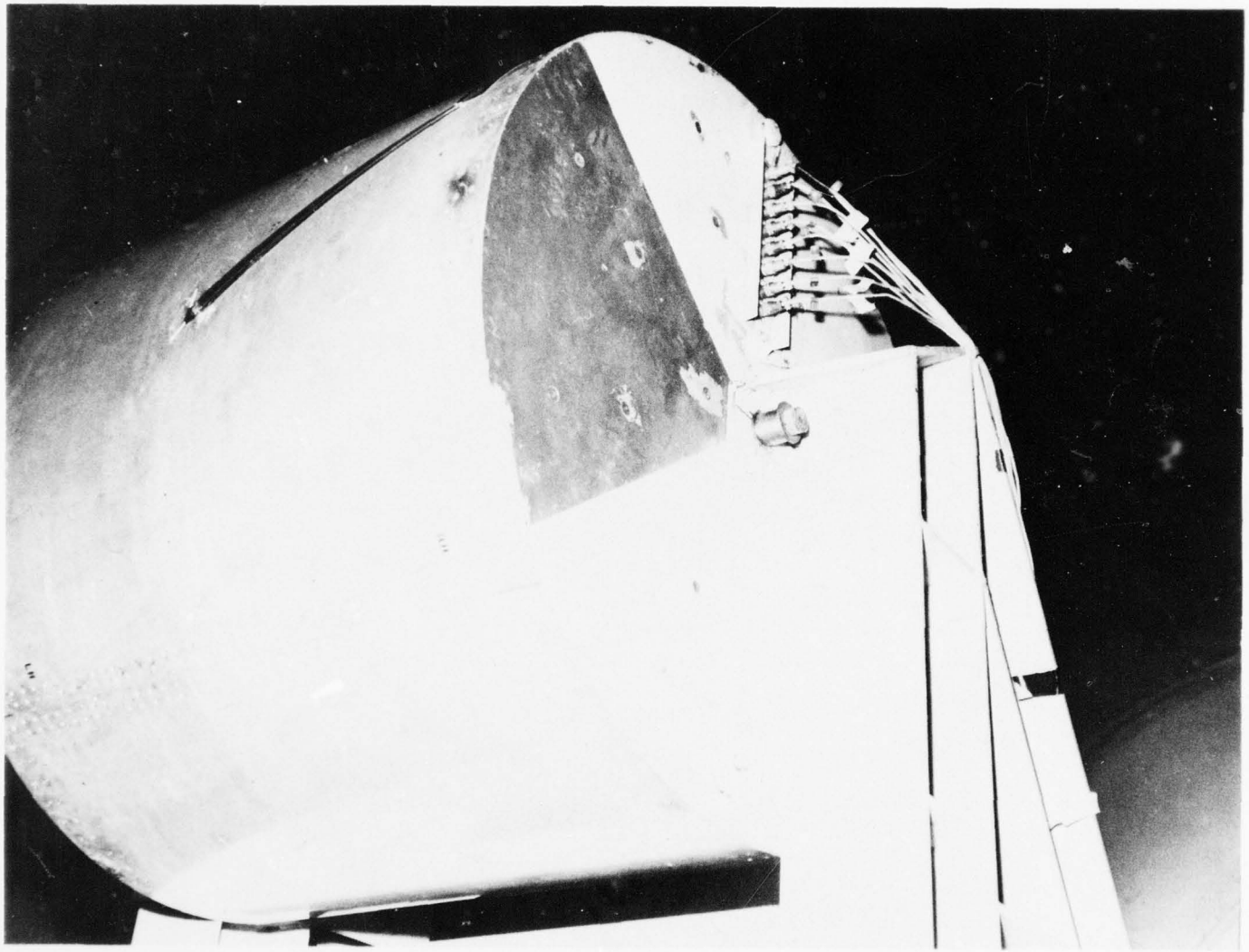


FIGURE 13-5 - SPECIMEN NO. 13 - SHOCK TEST SET-UP - RIGHT SIDE

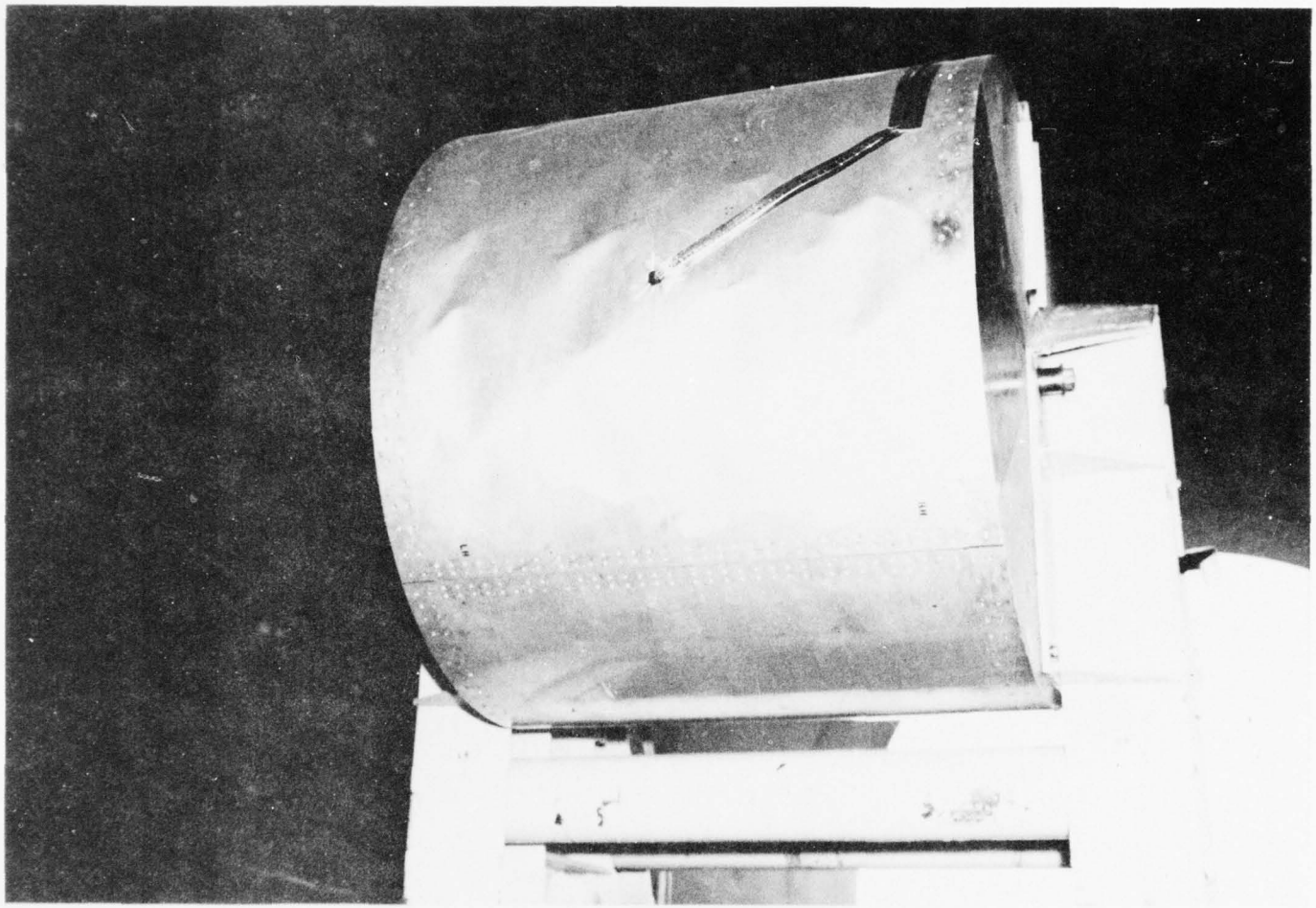


FIGURE 13-6 - SPECIMEN NO. 13 - SKIN WRINKLES AFTER THIRD SHOT - FRONT VIEW

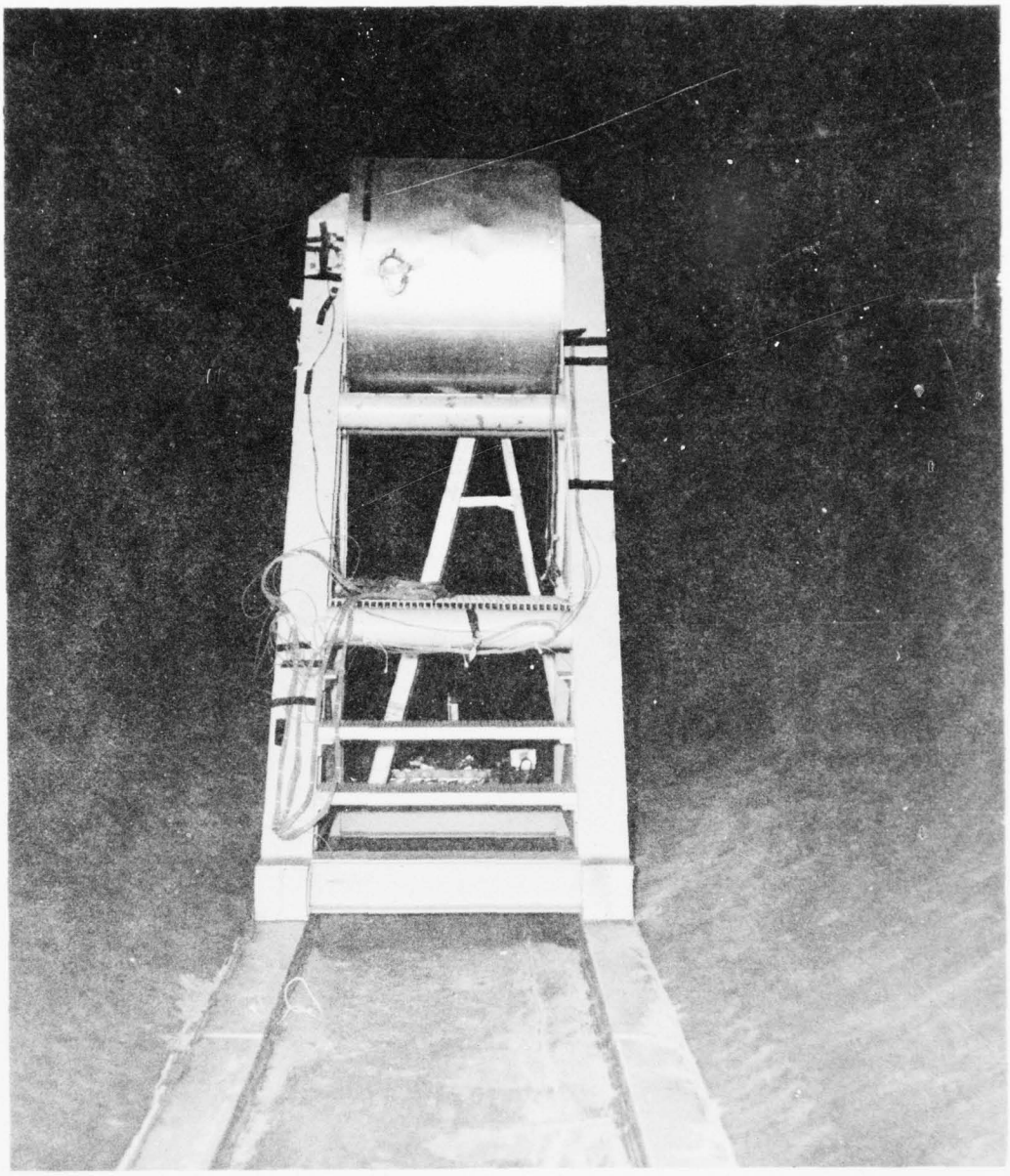


FIGURE 13-7 - SPECIMEN NO. 13 - SKIN WRINKLES AFTER THIRD SHOT - REAR VIEW

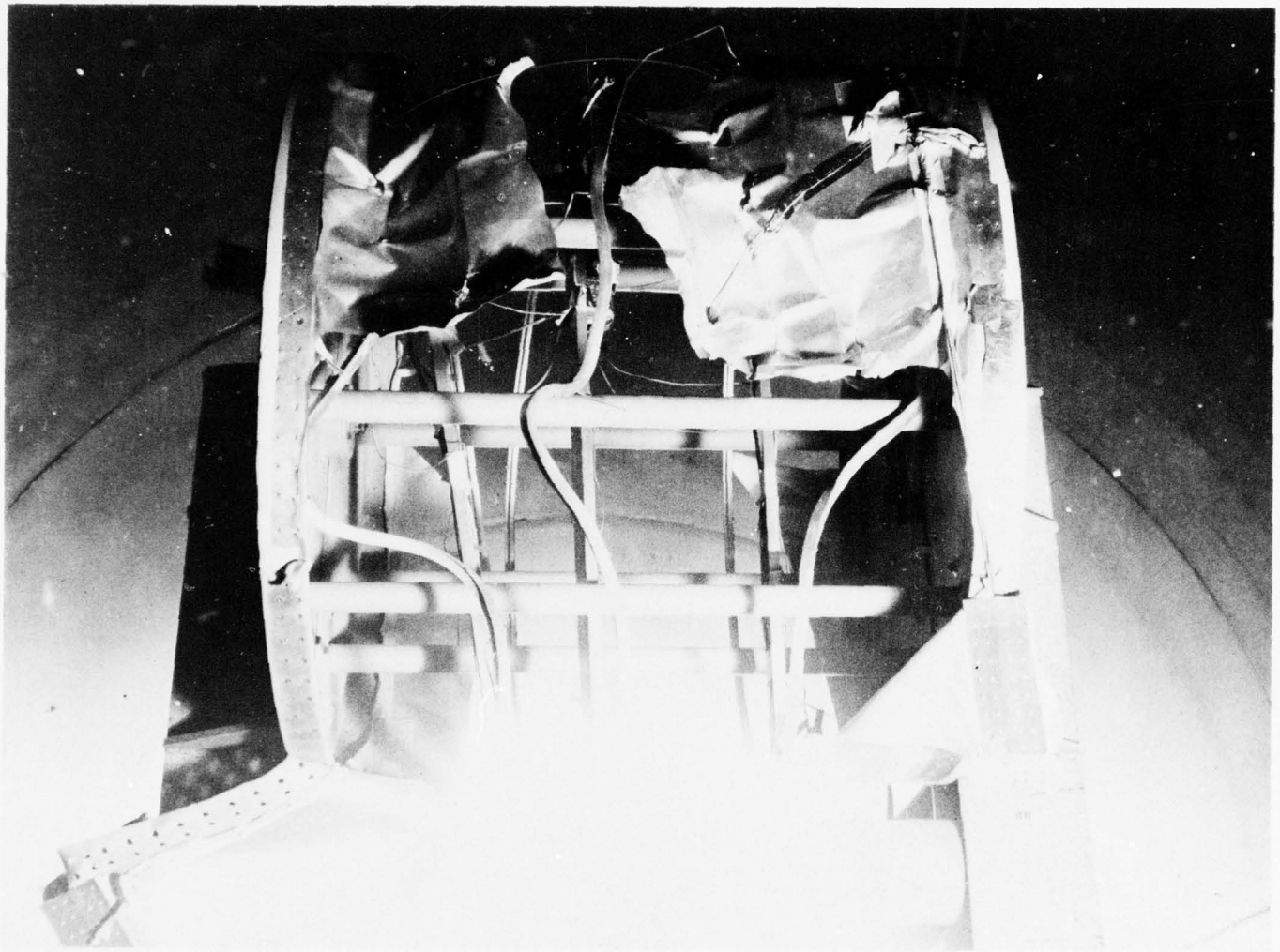


FIGURE 13-8 - SPECIMEN NO. 13 - CATASTROPHIC DAMAGE AFTER FINAL SHOT - FRONT VIEW

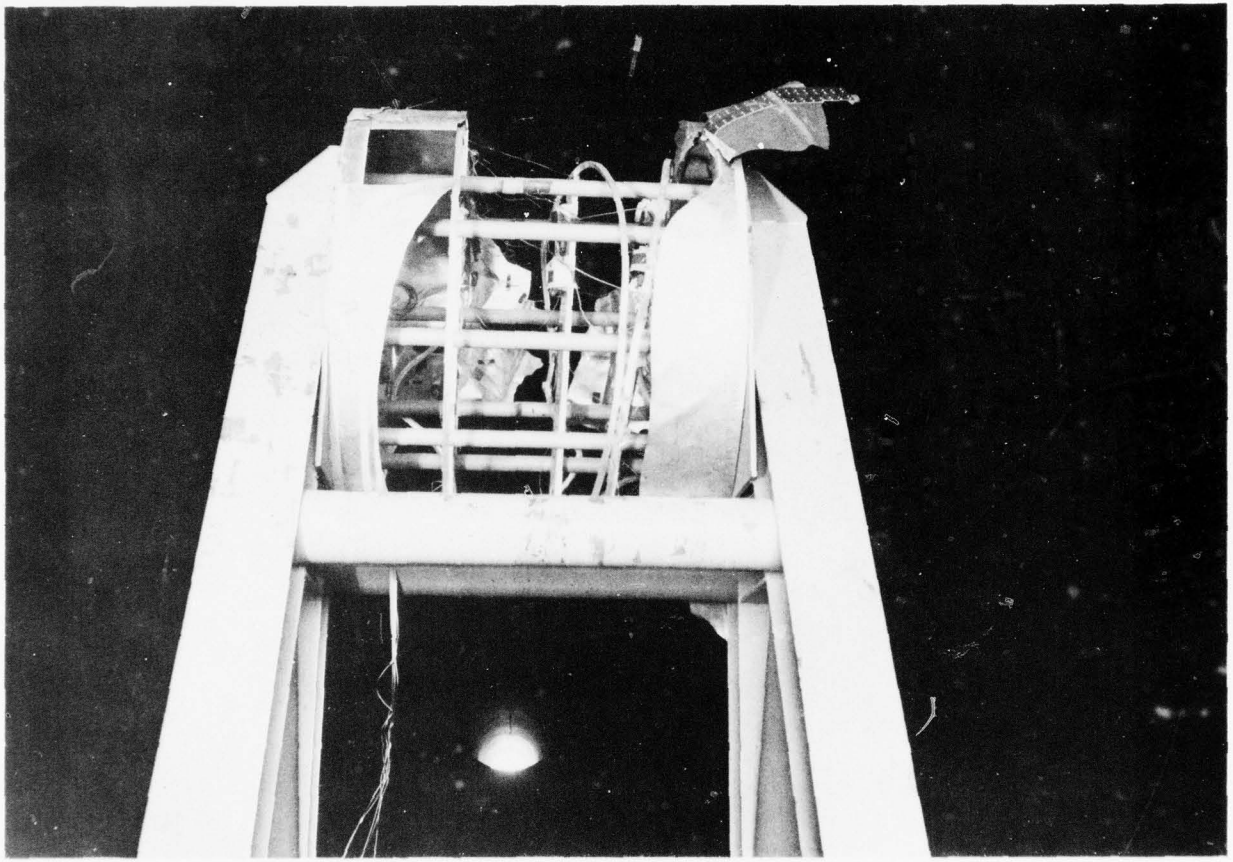


FIGURE 13-9 - SPECIMEN NO. 13 - CATASTROPHIC DAMAGE AFTER FINAL SHOT -REAR VIEW

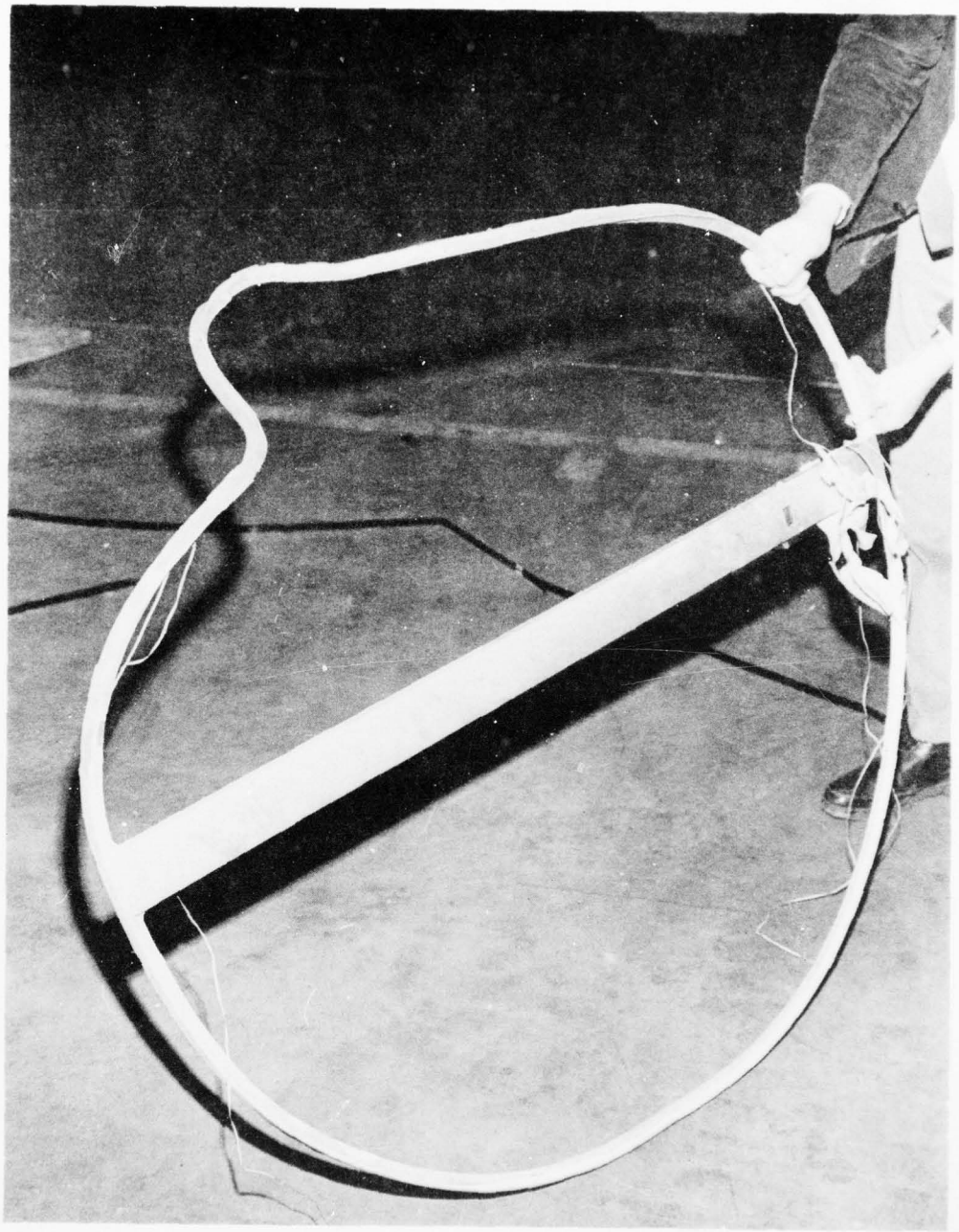


FIGURE 13-10 - SPECIMEN NO. 13 - CENTER FRAME DAMAGE - FRONT SIDE IS UP

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO. 13 - DYNAMIC ANALYSIS - ITERATIVE TPD SOLUTION                GP  1
          1            0                                                        GP  2
5000.      0.001        0.02         0.0                                        GP  3
0.0        0.0          0.0          0.0                                        GP  4
         15           15                                                        GP  5
1200.                                                                           GP  7
                                                                                GP  8
          2            0                                                        GP  9
          0            1                                                        GP 10
0.5                                                                             GP 11
          0            0                                                        GP 12
          0            0                                                        GP 15
          0            0                                                        GP 18
          3                                                                     GP 21
0.0        -36.0                                                                GP 22
0.0        0.0                                                                  GP 23
0.0        24.0                                                                 GP 24
-18.0      24.0                                                                 GP 24
-36.0      24.0                                                                 GP 24
          2            7                                                        GP 25
          2                                                                     GP 27
0.0                                                                             GP 29
                                                                                GP 30
          1            2            2           1           1          1      GPB  1
         32            3            4                                         GPB  2
23.645                                                                          GPB  3
0.0        3.14159                                                              GPB  4
          0                                                                     GPB  8
          1            1            1                                         GPB 12
.0002539   .0002539     .0002539                                              GPB 13
9.0                                                                             GPB 14
.02                                                                             GPB 15
1.77                                                                            GPB 16
          3                                                                     GPB 17
.00363     38618.                                                               GPB 18
.0062      44000.                                                               GPB 18
.0092      49000.                                                               GPB 18
          3                                                                     GPB 19
.005       53230.                                                               GPB 20
.007       53500.                                                               GPB 20
.0094      54000.                                                               GPB 20
0.106                                                                           GPB 15
0.706                                                                           GPB 16
          3                                                                     GPB 17
.00196     20800.                                                               GPB 18
.0029      21000.                                                               GPB 18
.0059      21500.                                                               GPB 18
          3                                                                     GPB 19
.00196     20800.                                                               GPB 20
.0029      21000.                                                               GPB 20
.0059      21500.                                                               GPB 20
0.602                                                                           GPB 15
0.148                                                                           GPB 16
          3                                                                     GPB 17
.00196     20800.                                                               GPB 18
.0029      21000.                                                               GPB 18
.0059      21500.                                                               GPB 18
          3                                                                     GPB 19
.00196     20800.                                                               GPB 20
.0029      21000.                                                               GPB 20
.0059      21500.                                                               GPB 20
0.1     E-050.00353     25.0                                                    GPB 22
                                                                                GP  32
```

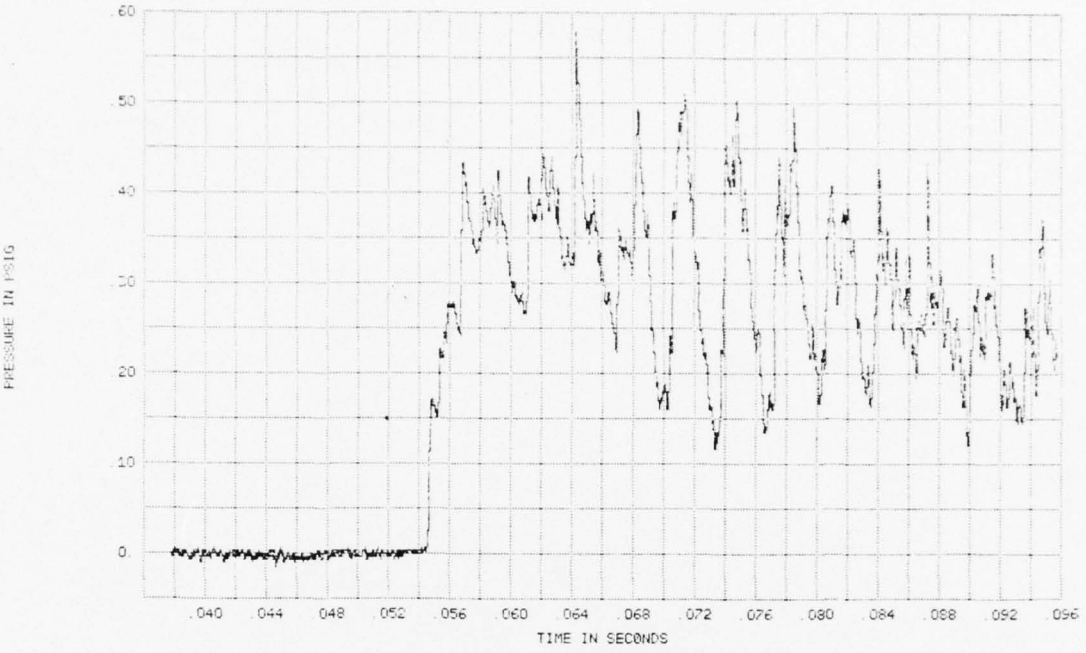


FIGURE 12-12 , SPECIMEN NO. 12 , SHOT NO. 1 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

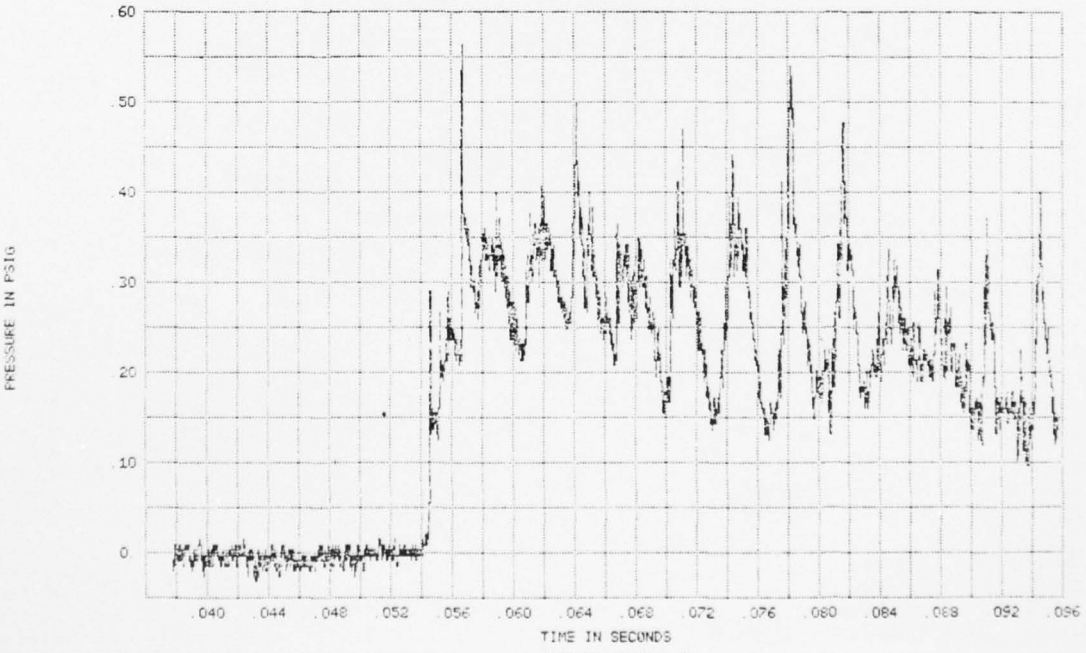


FIGURE 12-13 , SPECIMEN NO. 12 , SHOT NO. 1 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

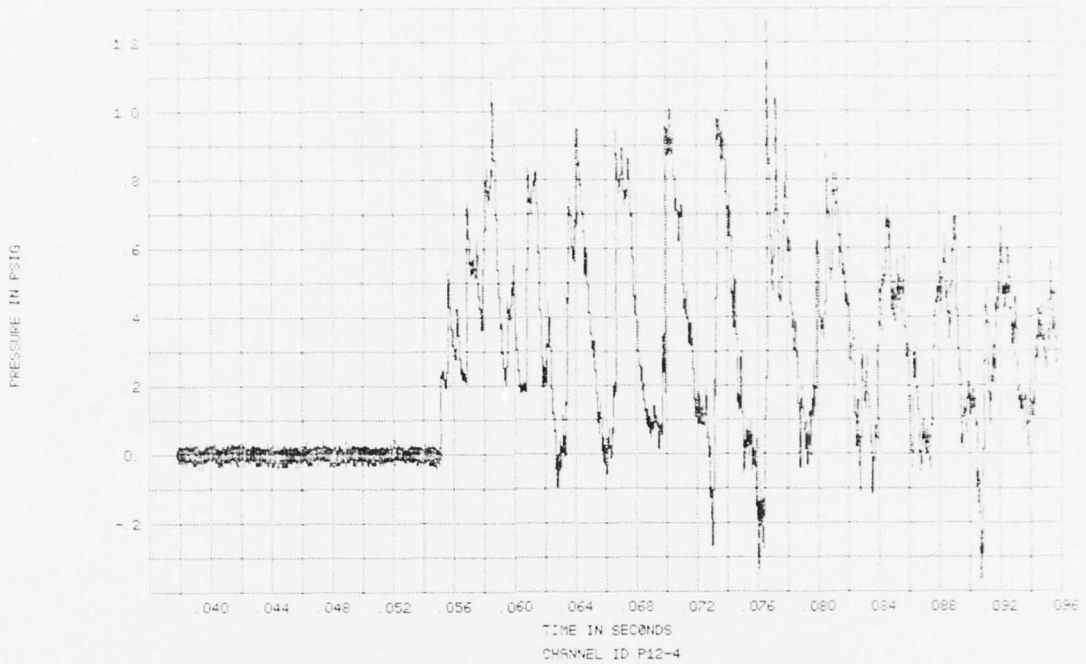


FIGURE 12-14 , SPECIMEN NO. 12 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

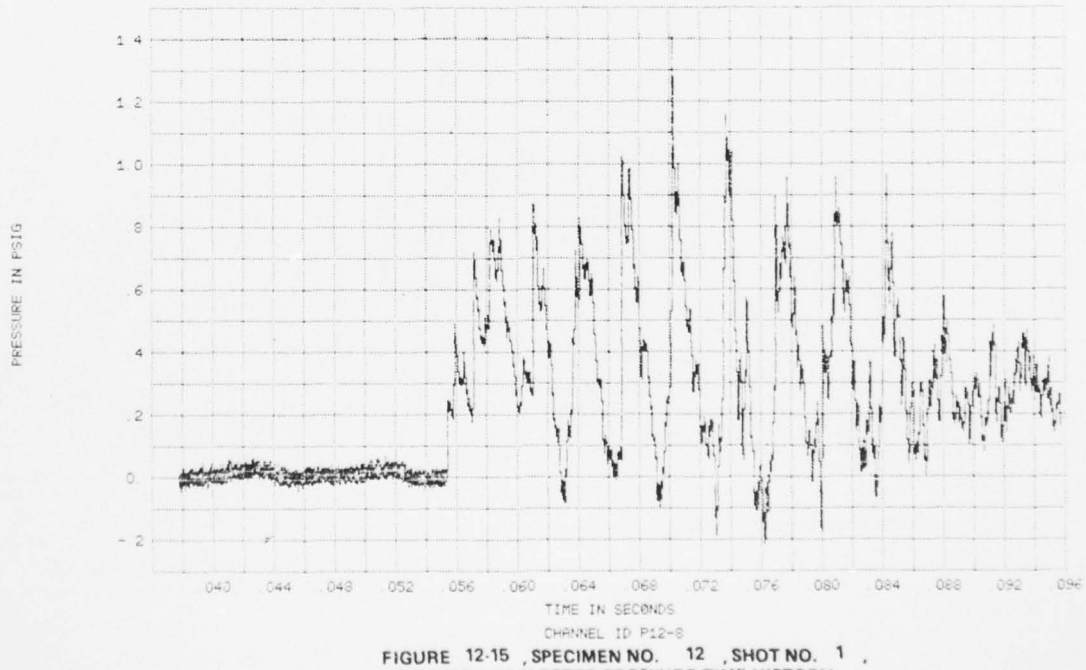


FIGURE 12-15 , SPECIMEN NO. 12 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

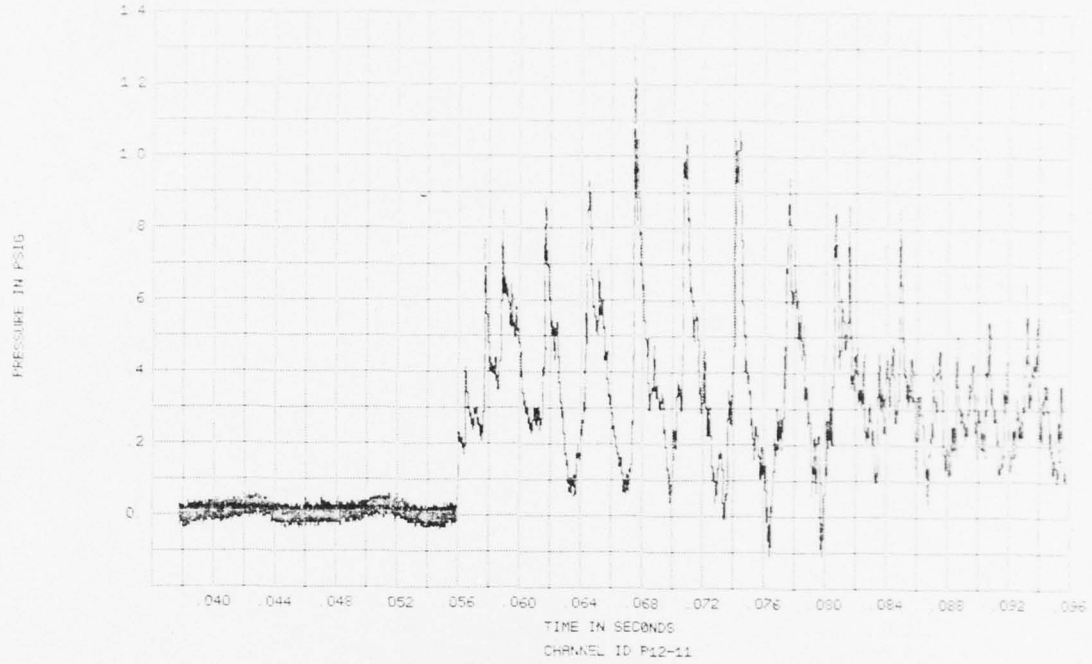


FIGURE 12-16 , SPECIMEN NO. 12 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

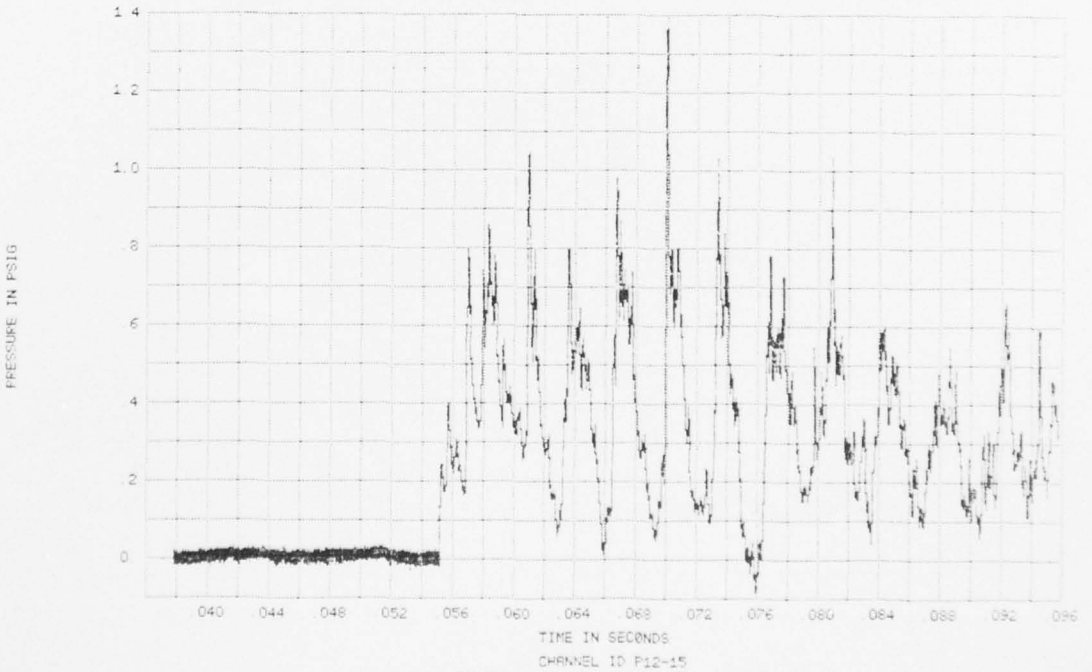


FIGURE 12-17 , SPECIMEN NO. 12 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

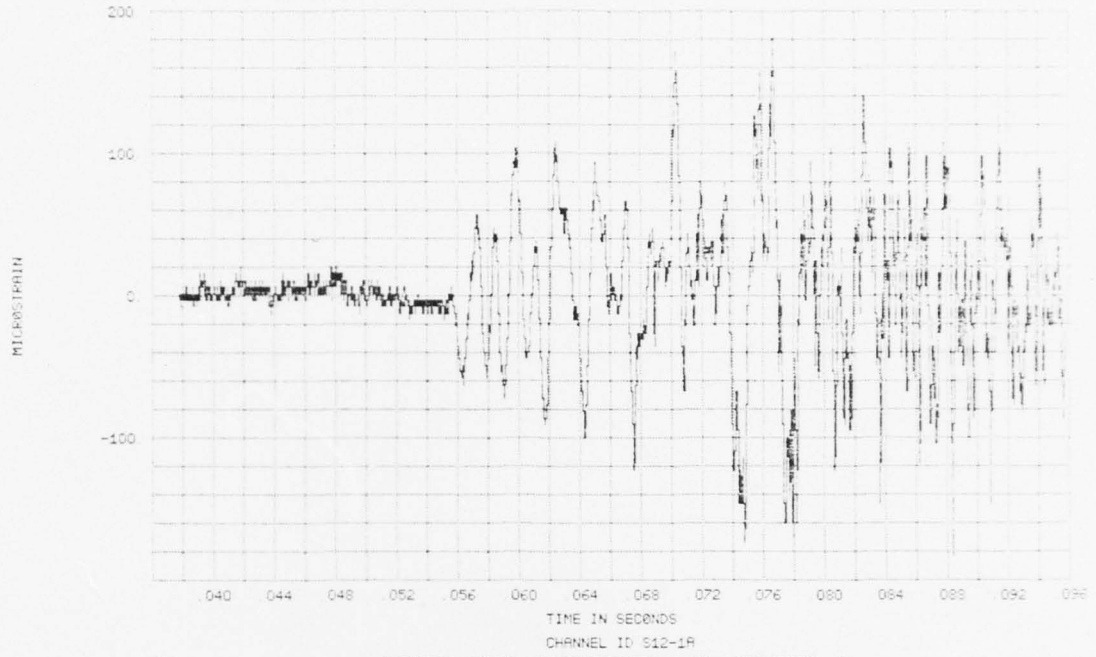


FIGURE 12-18 , SPECIMEN NO. 12 , SHOT NO. 1 ,
STRAIN TIME HISTORY

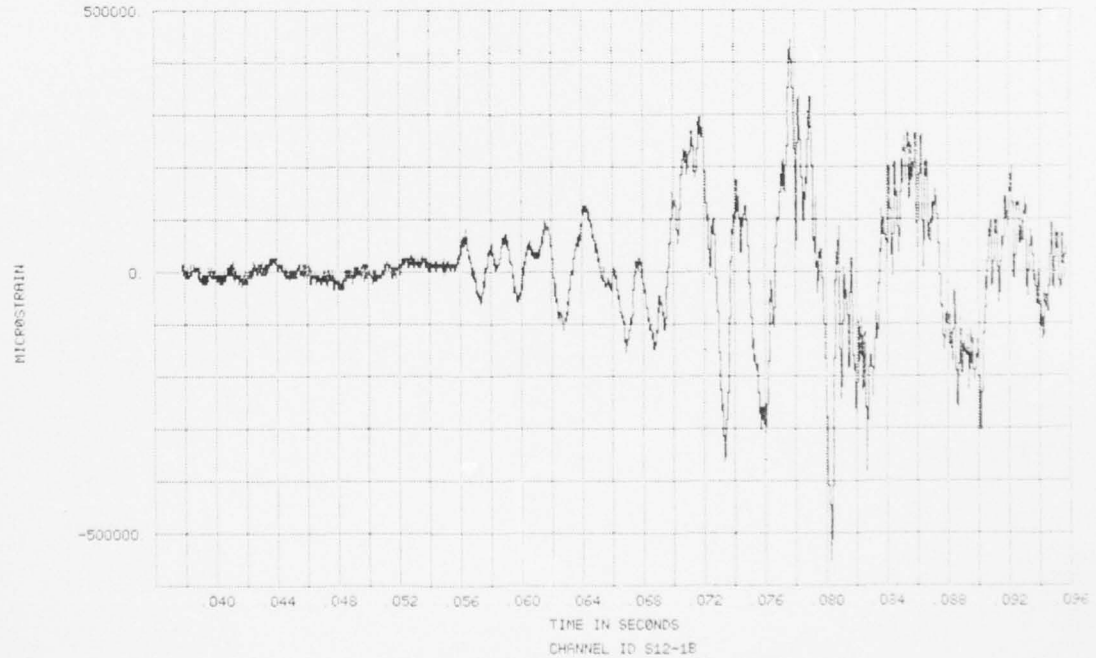


FIGURE 12-19 , SPECIMEN NO. 12 , SHOT NO. 1 ,
STRAIN TIME HISTORY

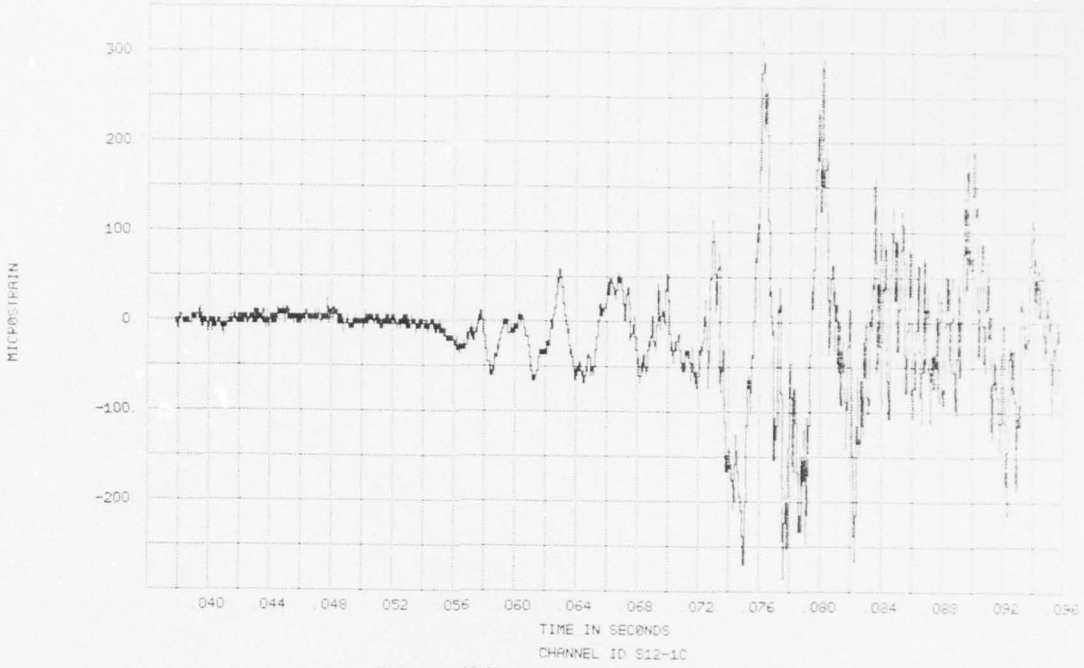


FIGURE 12-20 , SPECIMEN NO. 12 , SHOT NO. 1 ,
STRAIN TIME HISTORY

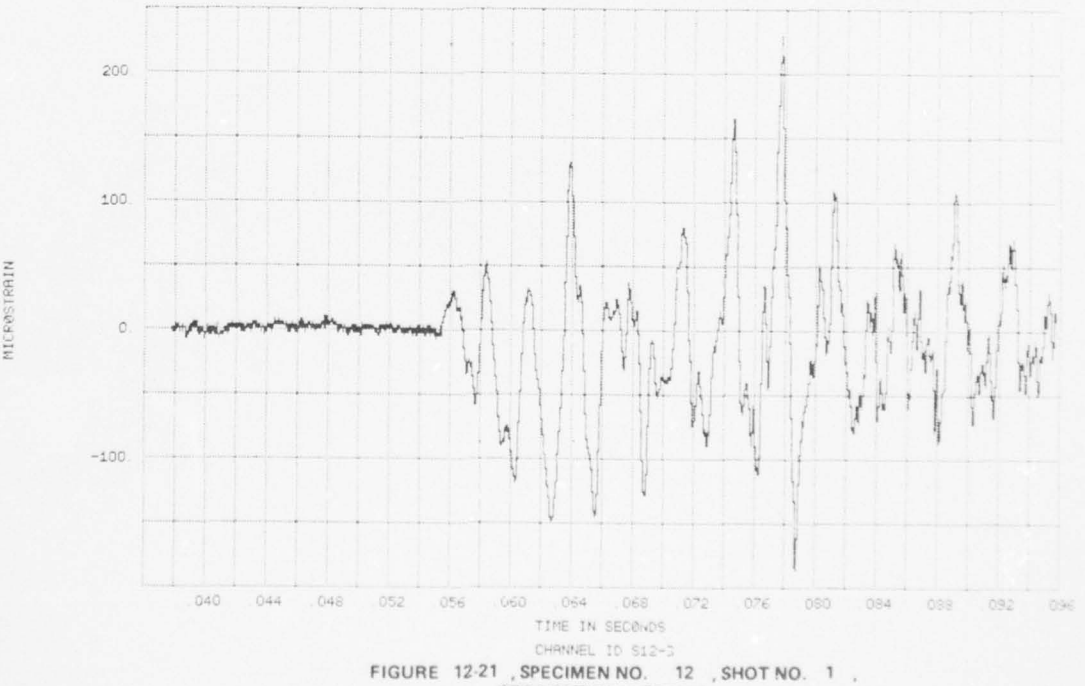
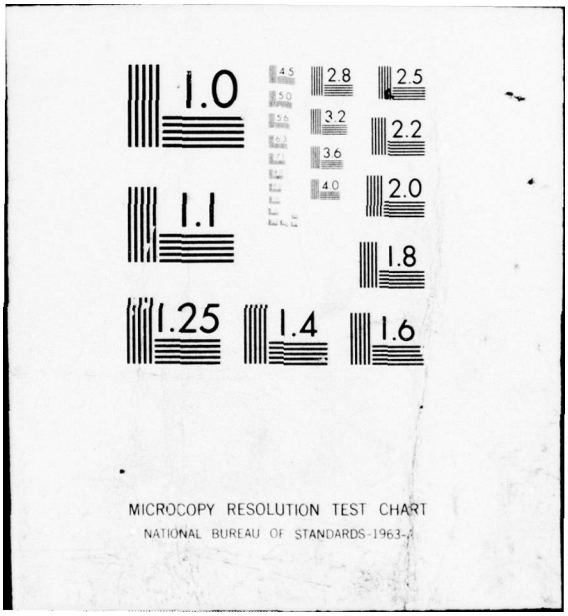


FIGURE 12-21 , SPECIMEN NO. 12 , SHOT NO. 1 ,
STRAIN TIME HISTORY

AD-A052 029 BOEING WICHITA CO KS F/G 18/3
STRUCTURAL RESPONSE TO SIMULATED NUCLEAR OVERPRESSURE (STRESNO)--ETC(U)
MAR 77 R P SYRING, W D PIERSON DNA001-76-C-0084
UNCLASSIFIED D3-9788-5-VOL-2 DNA-4278F-2 NL

7 OF 8
AD A052 029




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
7.1
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

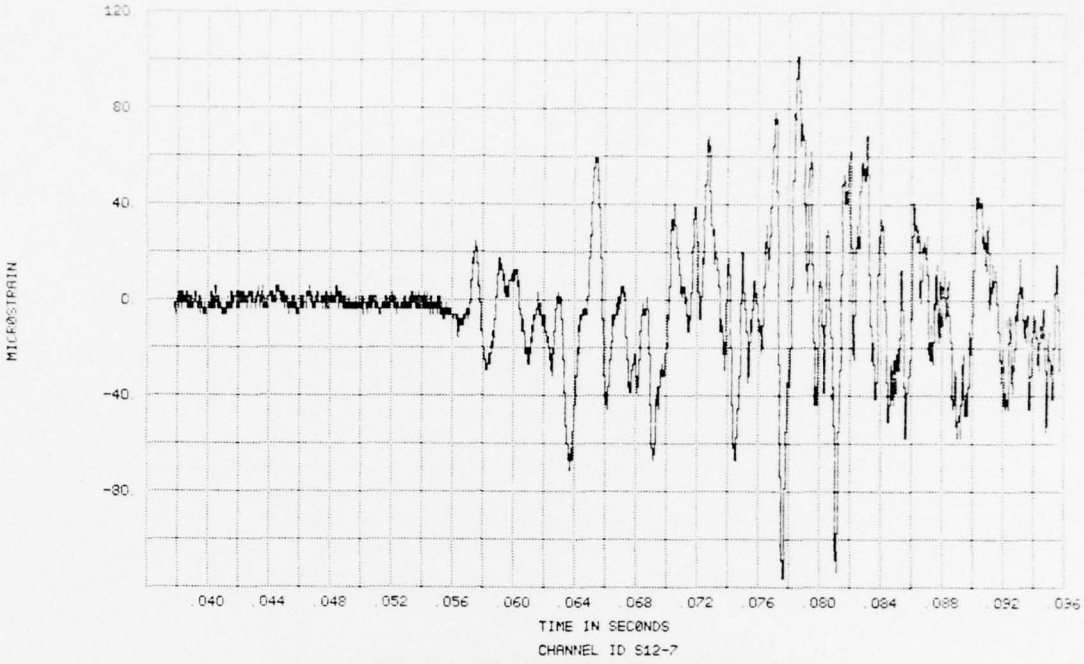


FIGURE 12-22 , SPECIMEN NO. 12 , SHOT NO. 1 , STRAIN TIME HISTORY

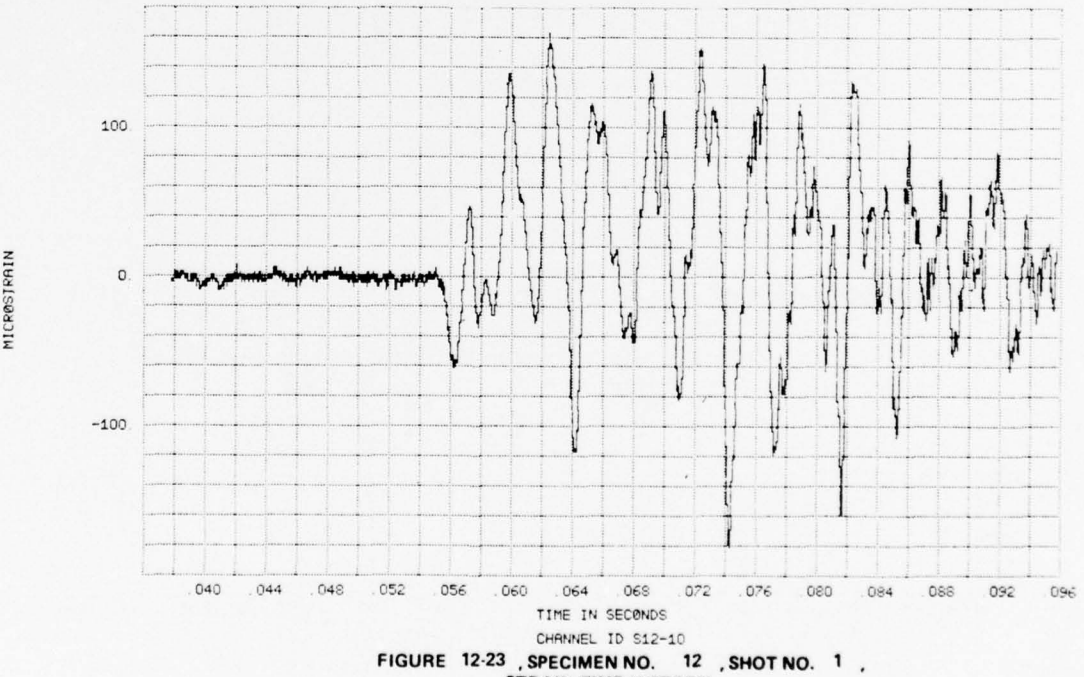


FIGURE 12-23 , SPECIMEN NO. 12 , SHOT NO. 1 , STRAIN TIME HISTORY

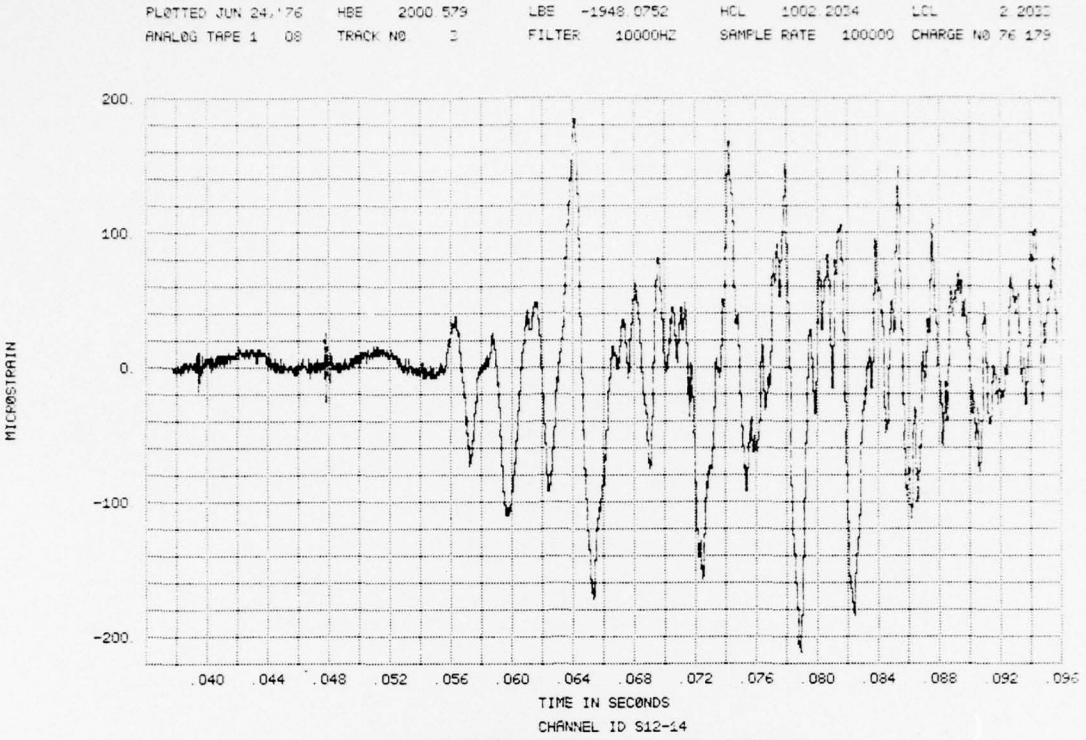


FIGURE 12-24 , SPECIMEN NO. 12 , SHOT NO. 1
STRAIN TIME HISTORY

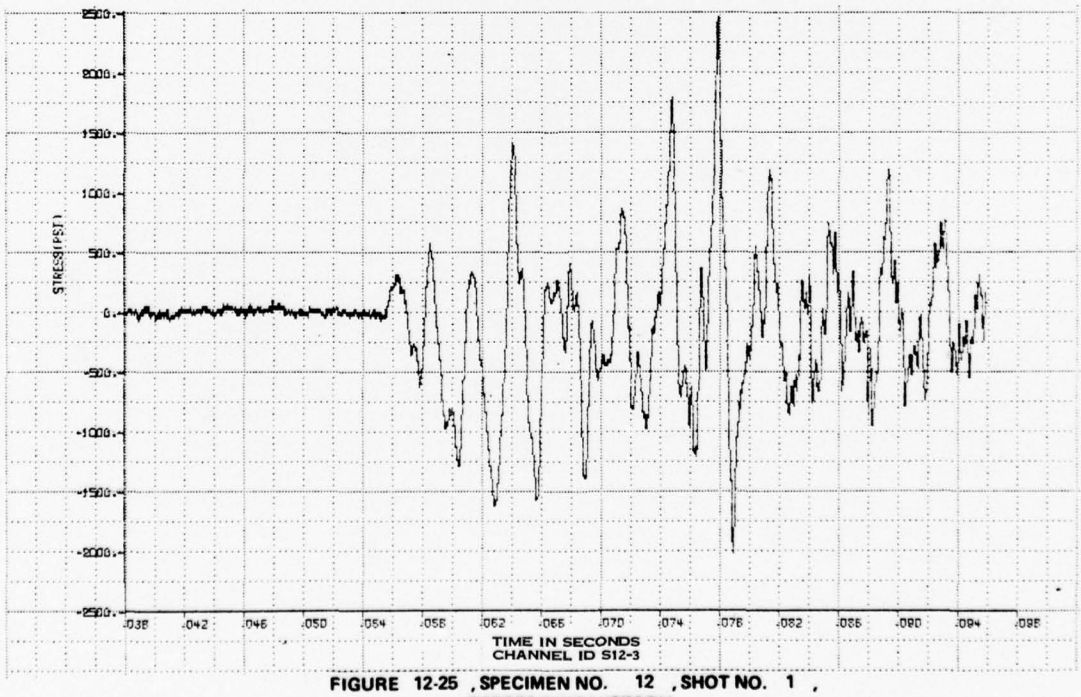


FIGURE 12-25 , SPECIMEN NO. 12 , SHOT NO. 1 ,
STRESS TIME HISTORY

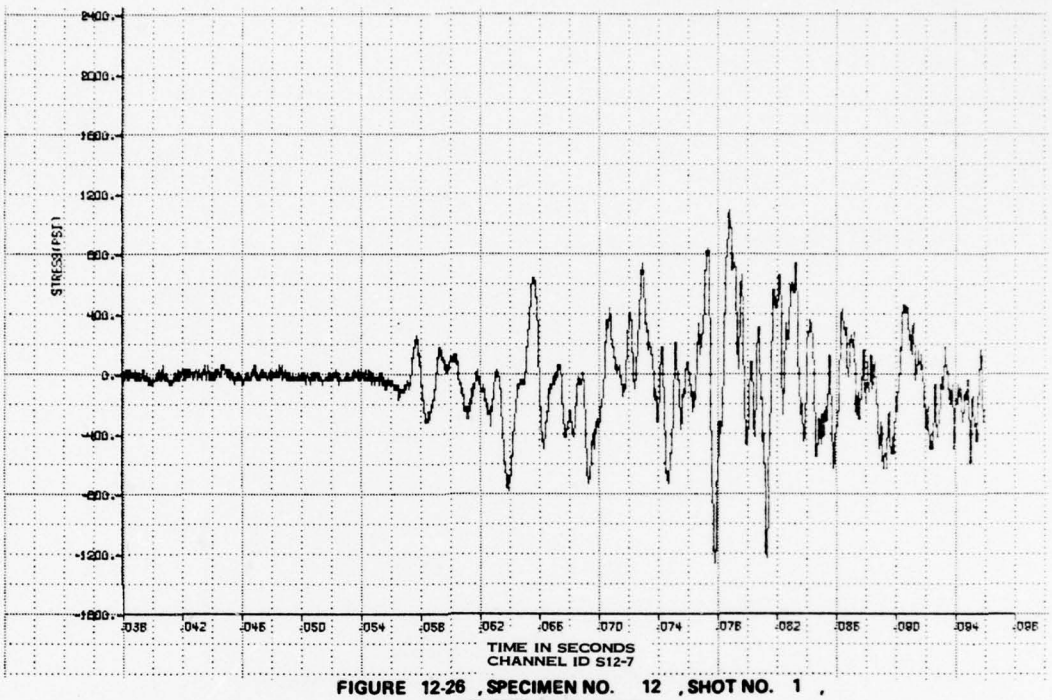


FIGURE 12-26 , SPECIMEN NO. 12 , SHOT NO. 1 ,
STRESS TIME HISTORY

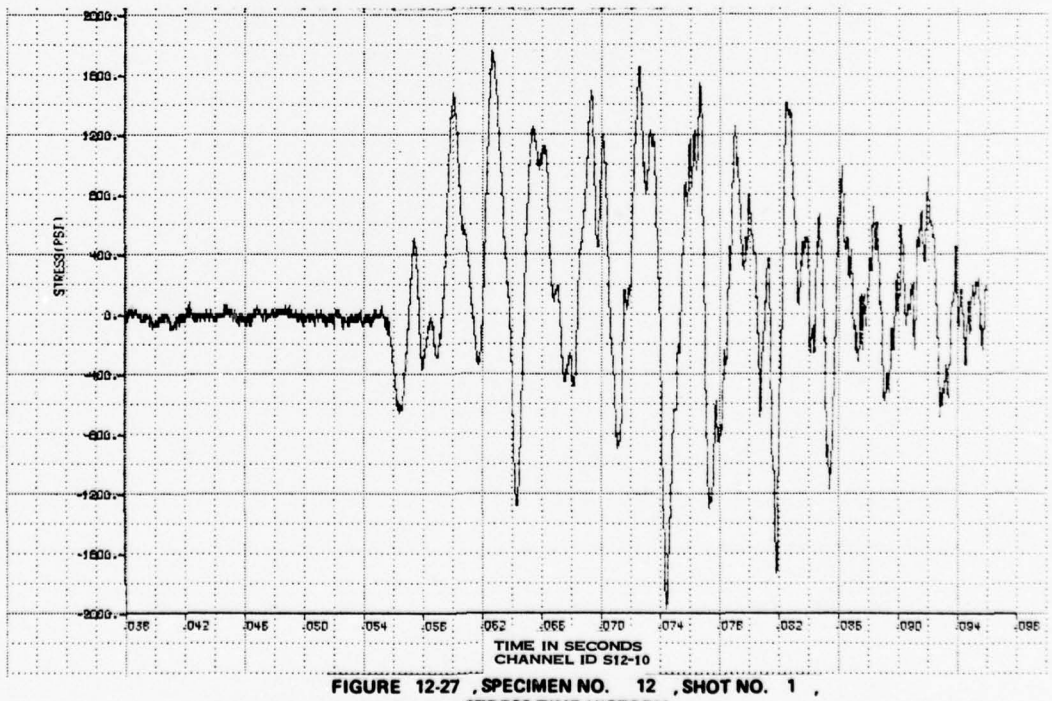


FIGURE 12-27 , SPECIMEN NO. 12 , SHOT NO. 1 ,
STRESS TIME HISTORY

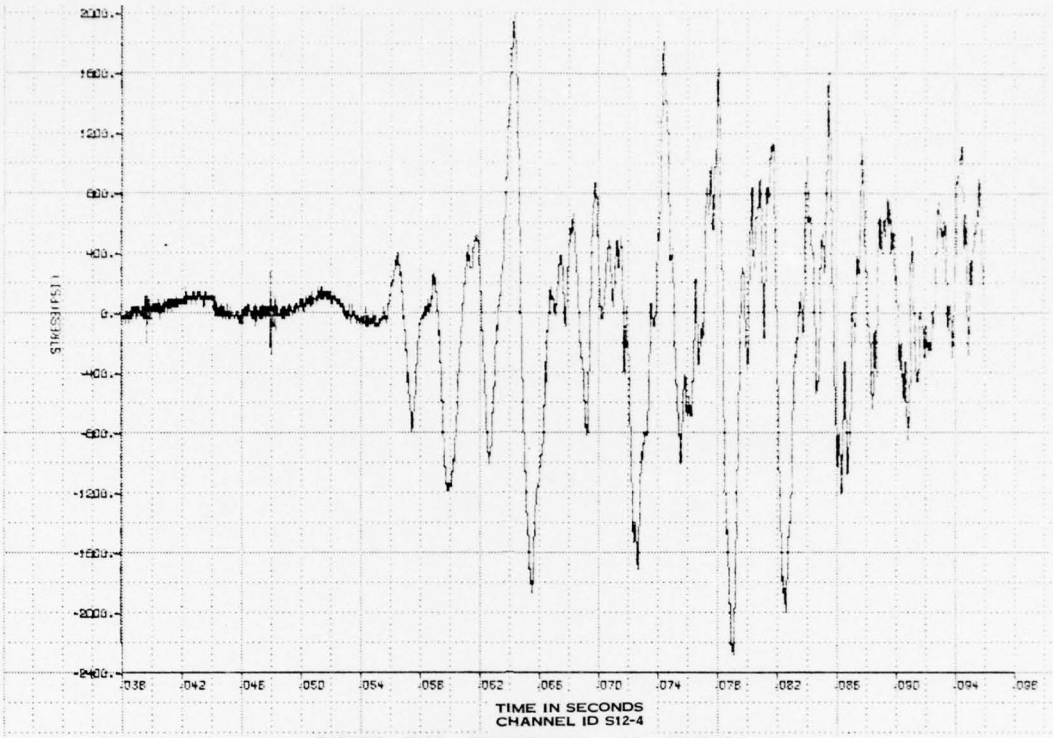


FIGURE 12-28 , SPECIMEN NO. 12 , SHOT NO. 1 ,
STRESS TIME HISTORY

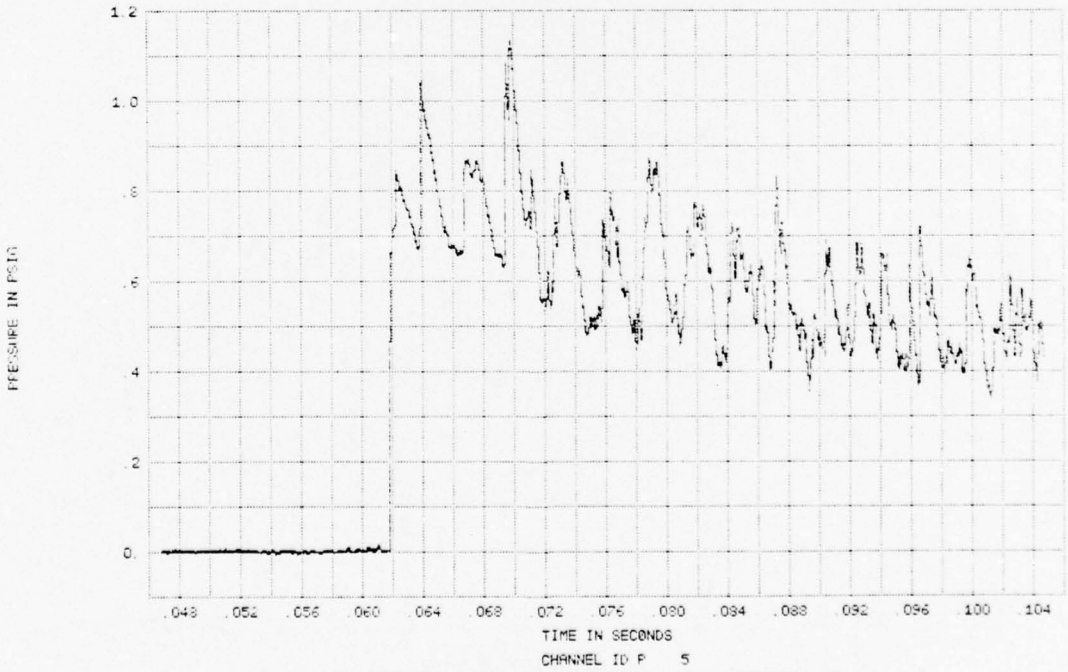


FIGURE 12-29 , SPECIMEN NO. 12 , SHOT NO. 2 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

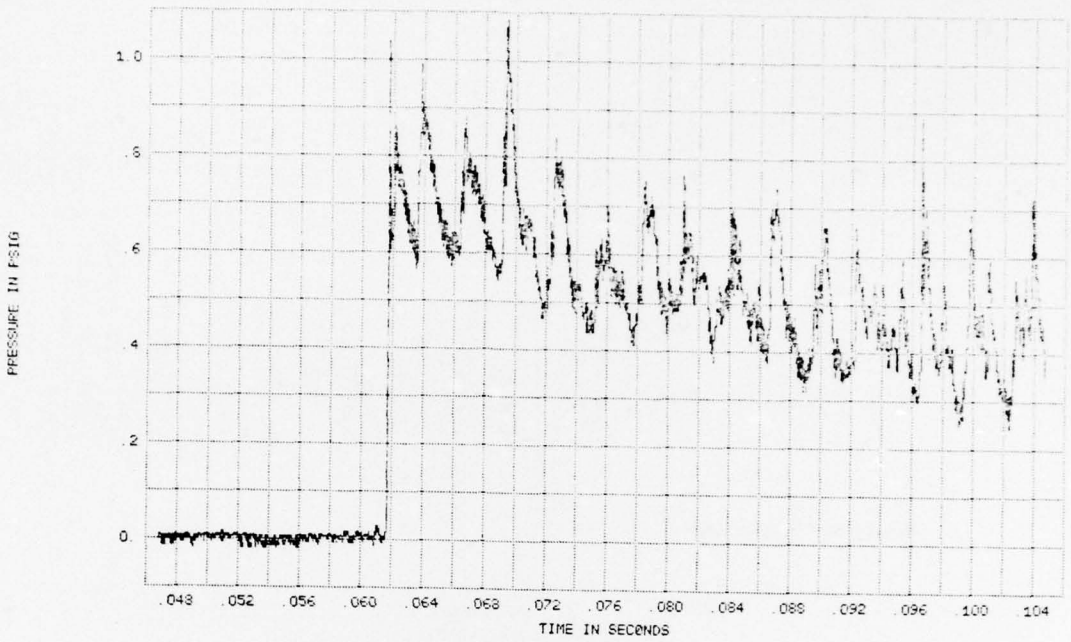


FIGURE 12-30 , SPECIMEN NO. 12 , SHOT NO. 2 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

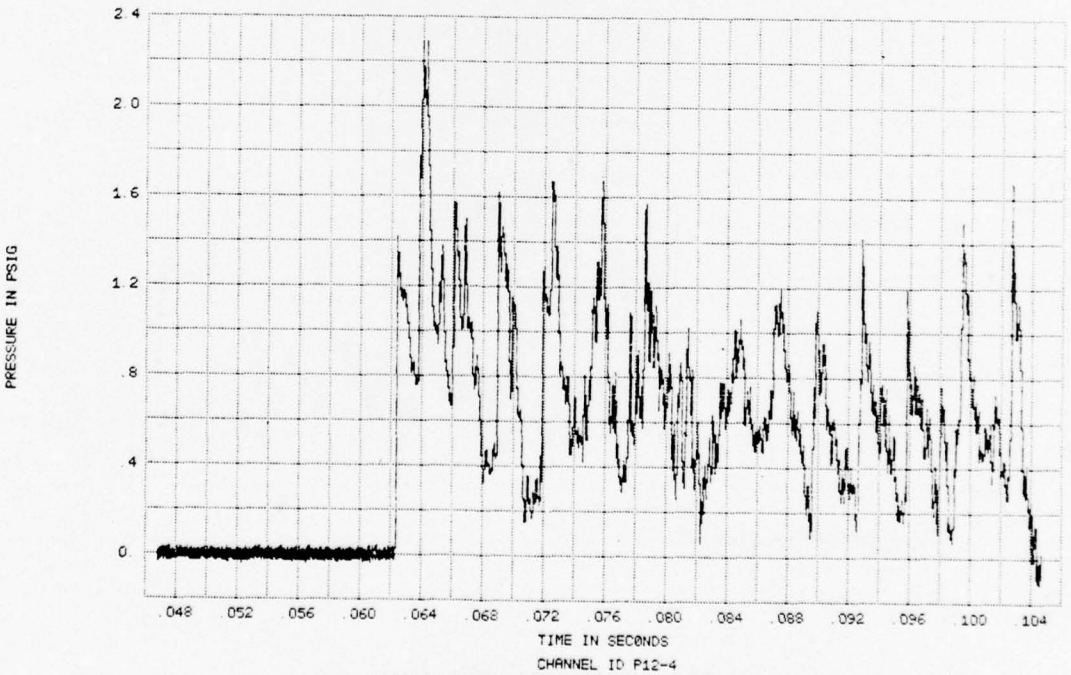


FIGURE 12-31 , SPECIMEN NO. 12 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

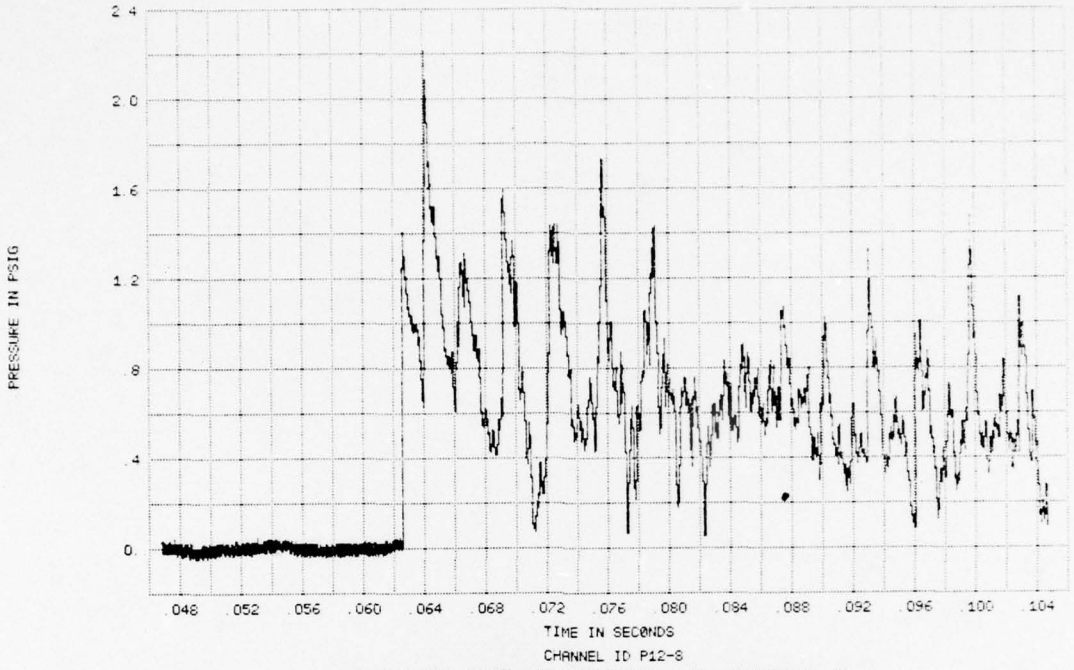


FIGURE 12-32 , SPECIMEN NO. 12 , SHOT NO. 2 , SPECIMEN REFLECTED PRESSURE TIME HISTORY

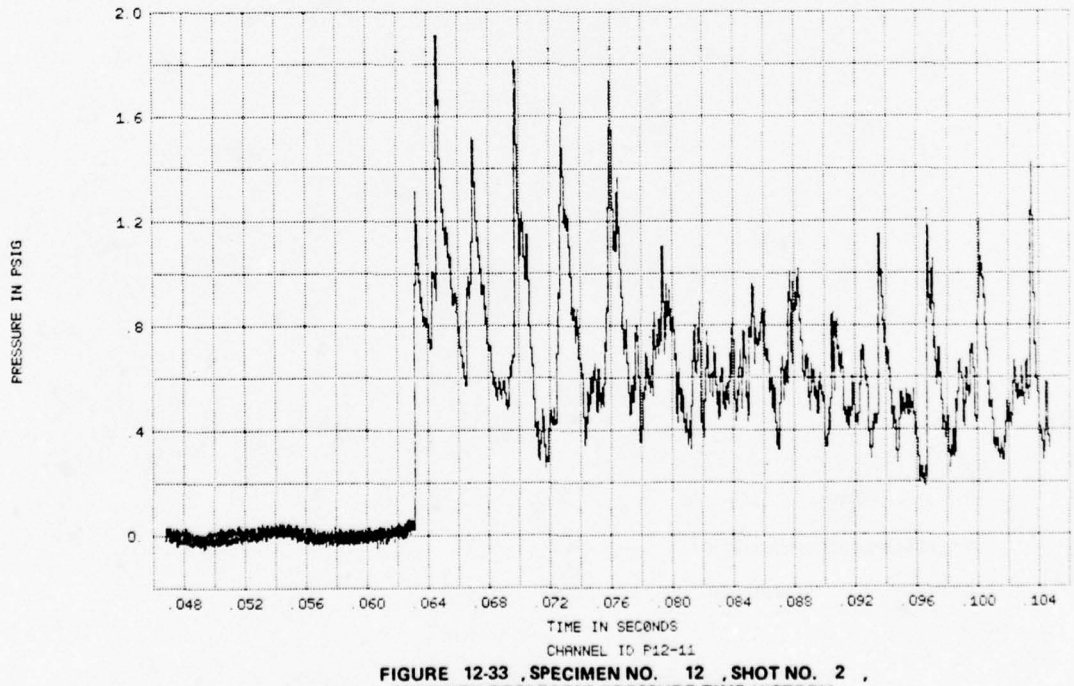


FIGURE 12-33 , SPECIMEN NO. 12 , SHOT NO. 2 , SPECIMEN REFLECTED PRESSURE TIME HISTORY

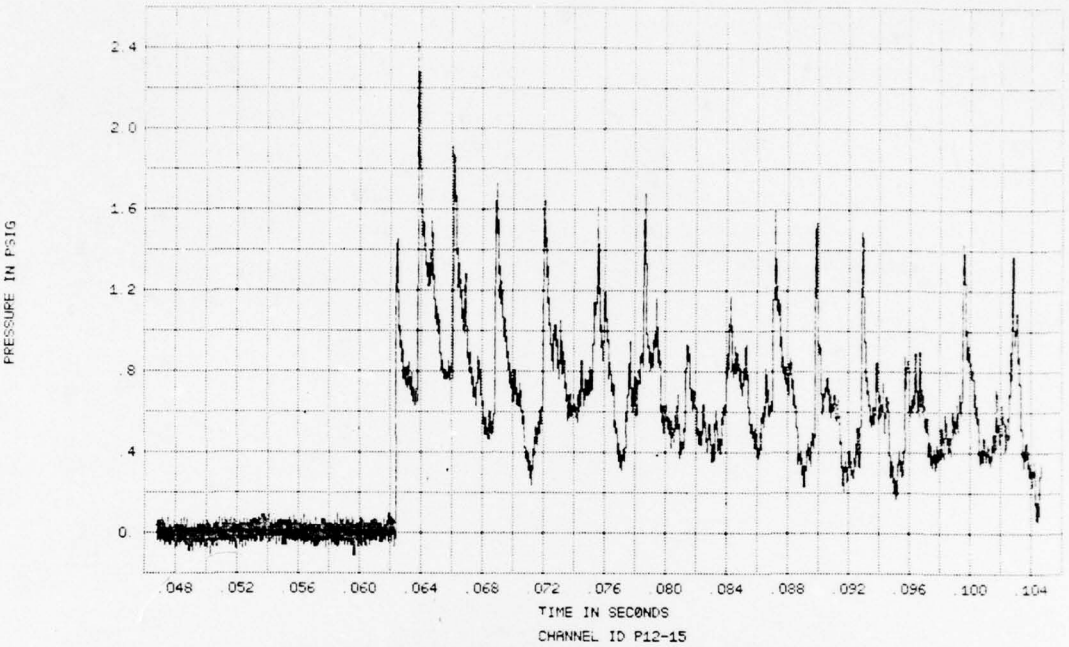


FIGURE 12-34 , SPECIMEN NO. 12 , SHOT NO. 2 , SPECIMEN REFLECTED PRESSURE TIME HISTORY

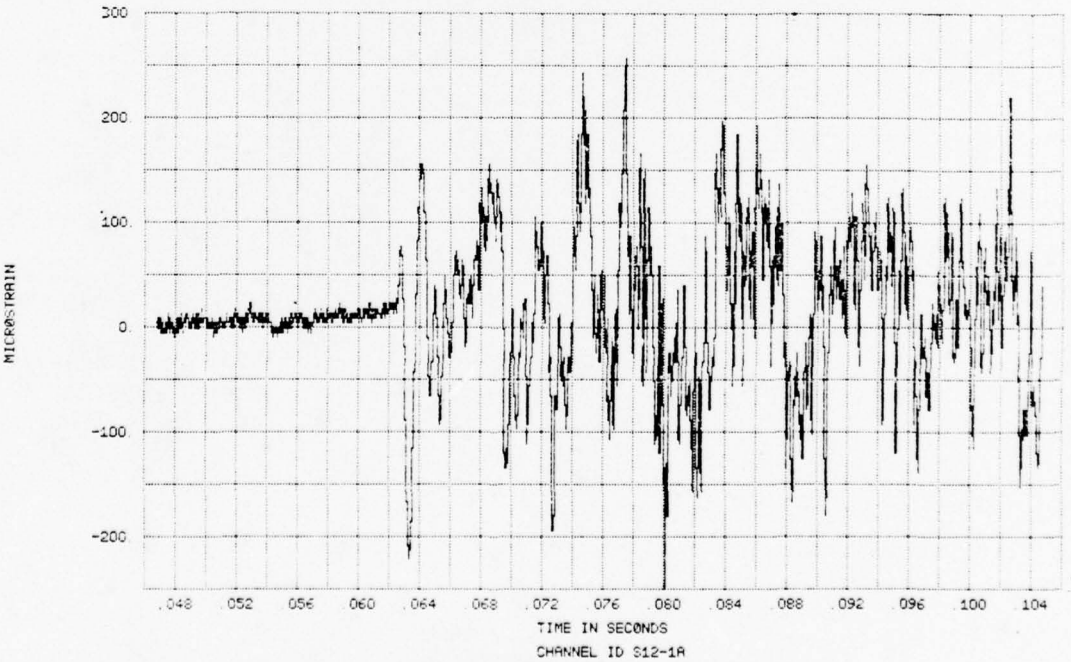


FIGURE 12-35 , SPECIMEN NO. 12 , SHOT NO. 2 , STRAIN TIME HISTORY

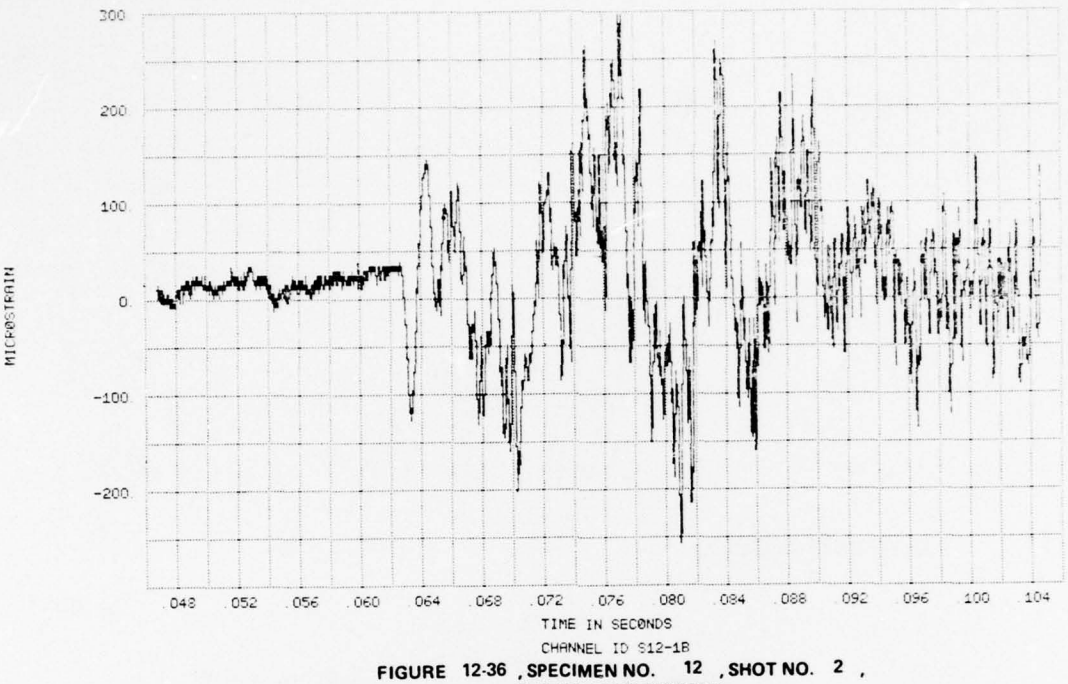


FIGURE 12-36 , SPECIMEN NO. 12 , SHOT NO. 2 , STRAIN TIME HISTORY

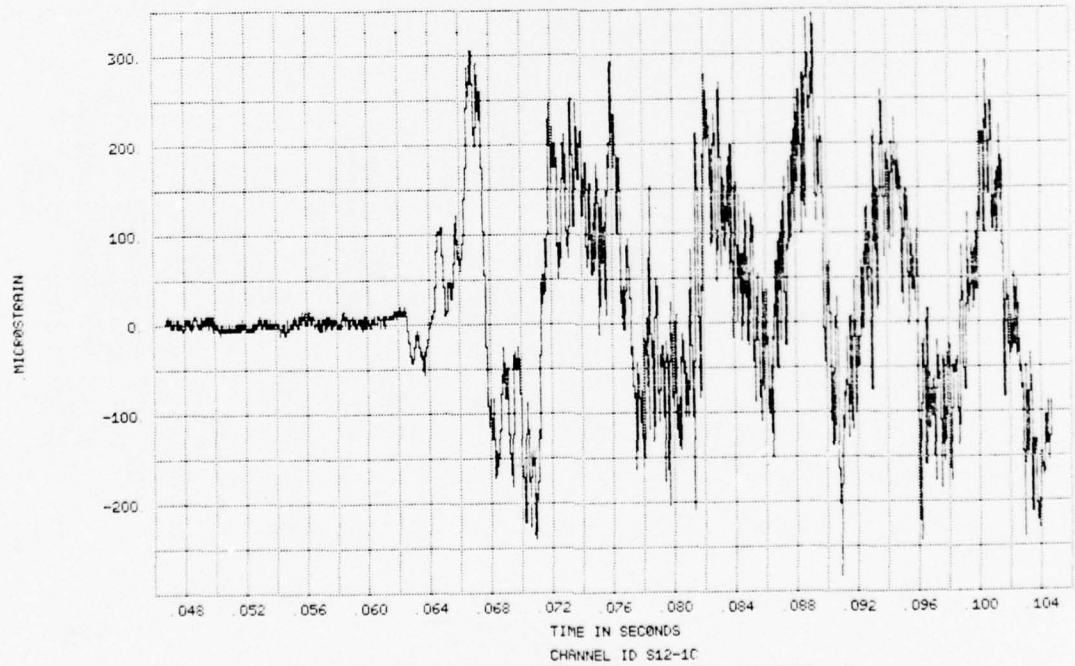


FIGURE 12-37 , SPECIMEN NO. 12 , SHOT NO. 2 , STRAIN TIME HISTORY

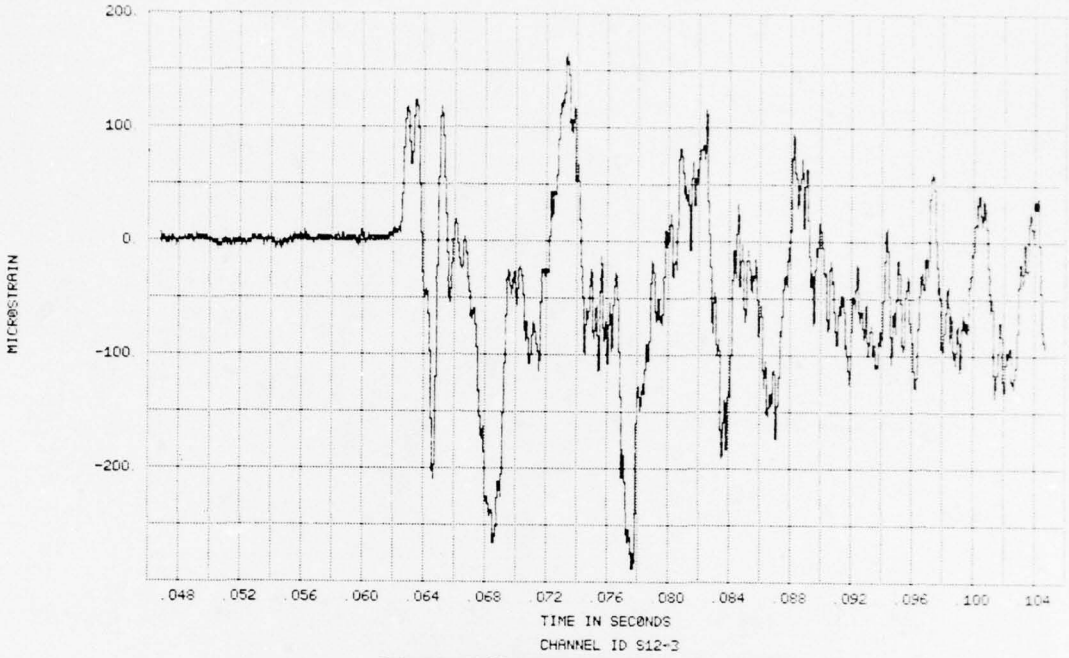


FIGURE 12-38 , SPECIMEN NO. 12 , SHOT NO. 2 , STRAIN TIME HISTORY

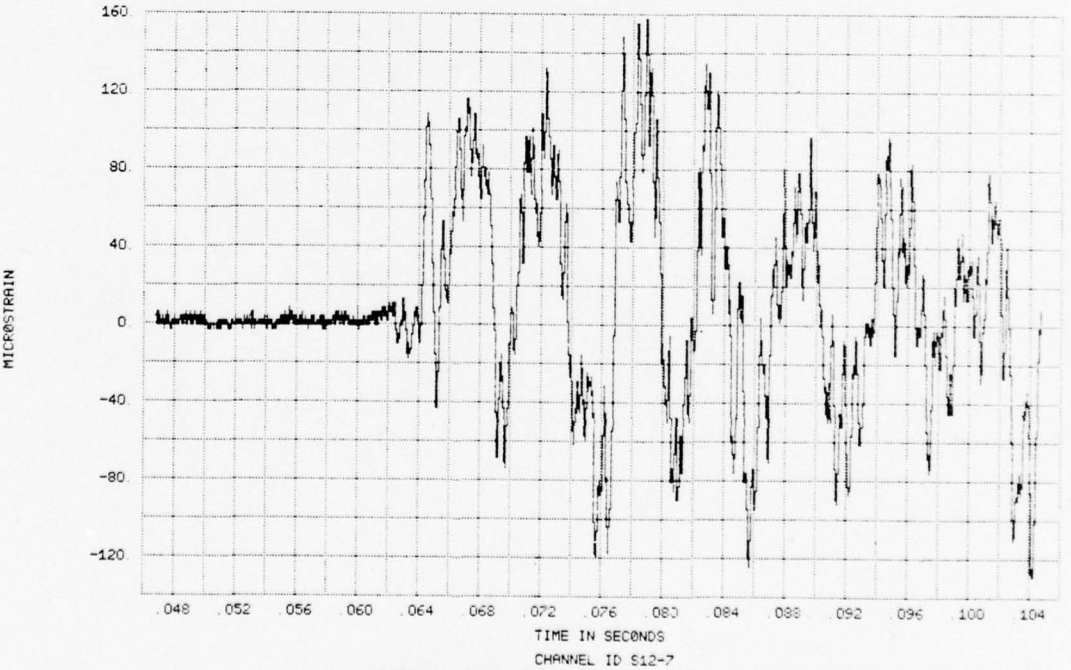


FIGURE 12-39 , SPECIMEN NO. 12 , SHOT NO. 2 , STRAIN TIME HISTORY

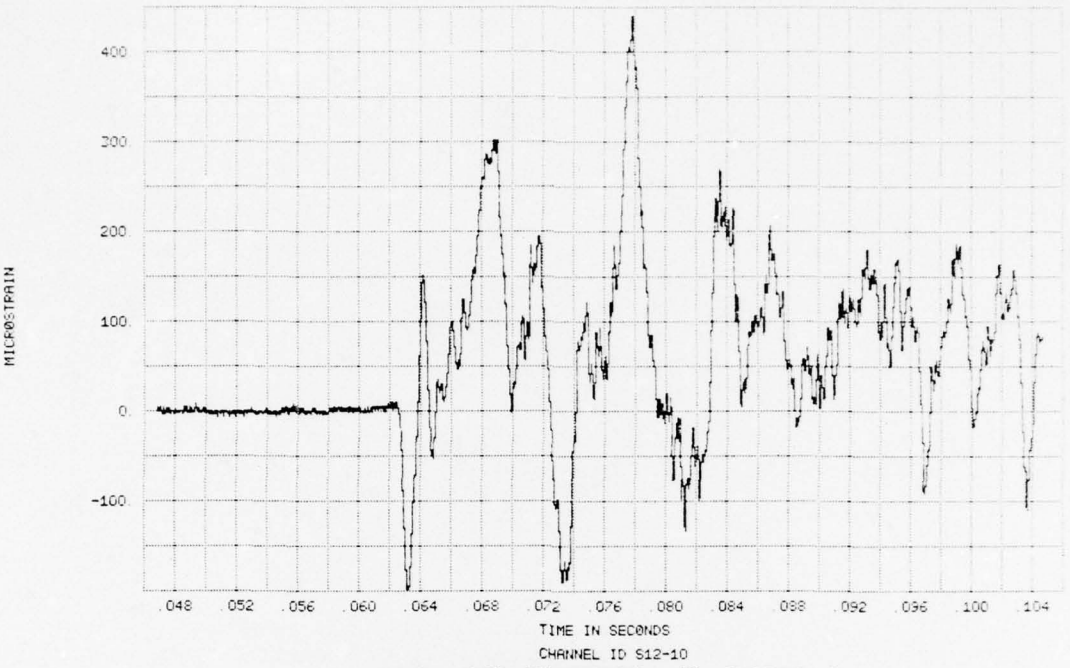


FIGURE 12-40 , SPECIMEN NO. 12 , SHOT NO. 2 , STRAIN TIME HISTORY

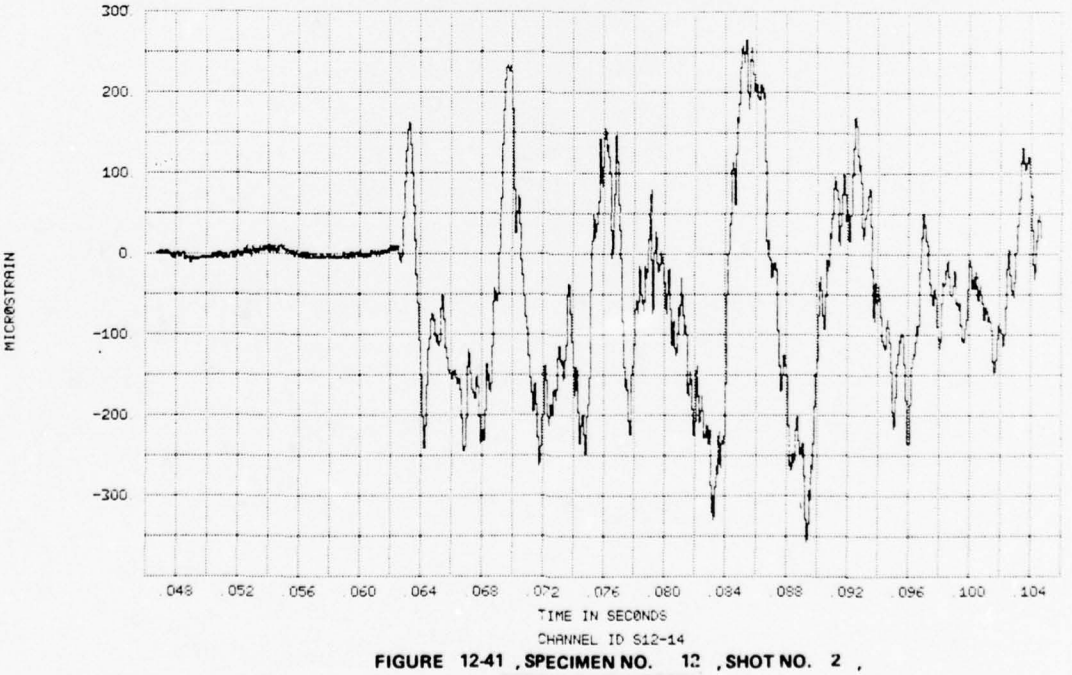


FIGURE 12-41 , SPECIMEN NO. 12 , SHOT NO. 2 , STRAIN TIME HISTORY

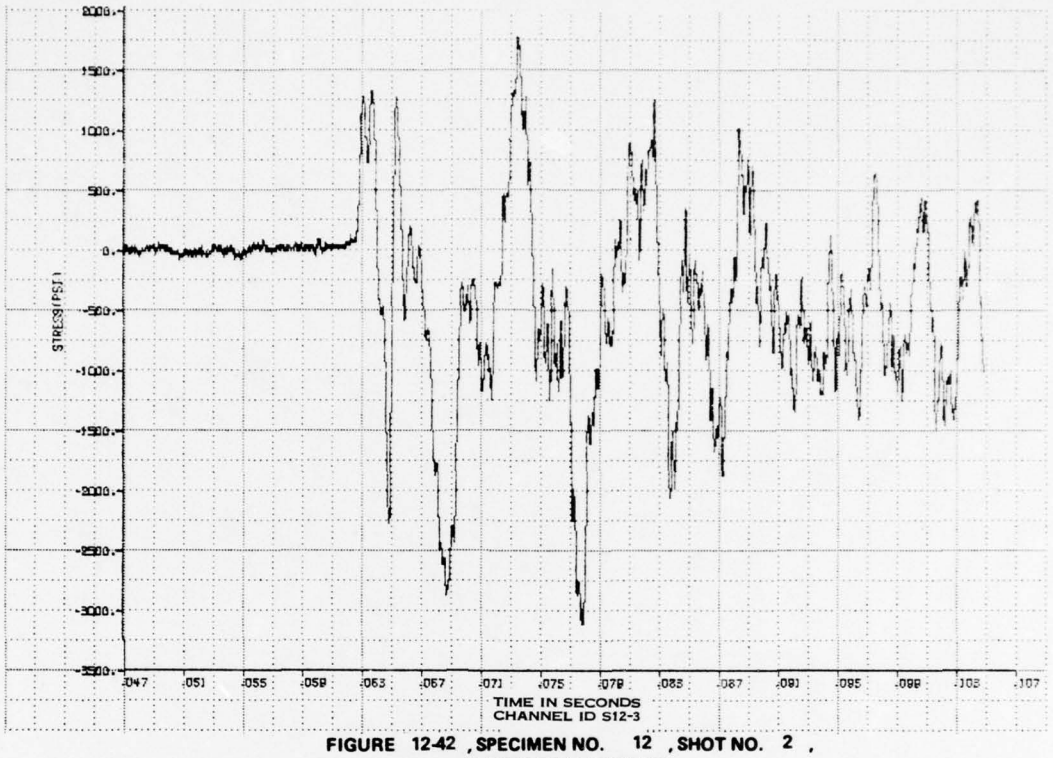


FIGURE 12-42 , SPECIMEN NO. 12 , SHOT NO. 2 ,
STRESS TIME HISTORY

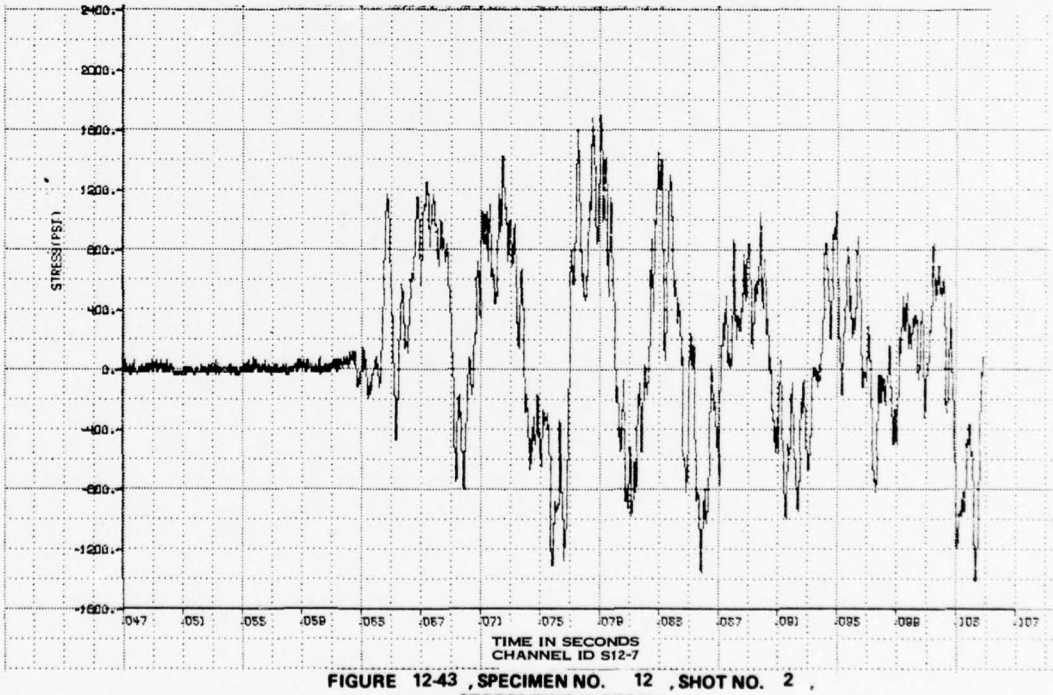


FIGURE 12-43 , SPECIMEN NO. 12 , SHOT NO. 2 ,
STRESS TIME HISTORY

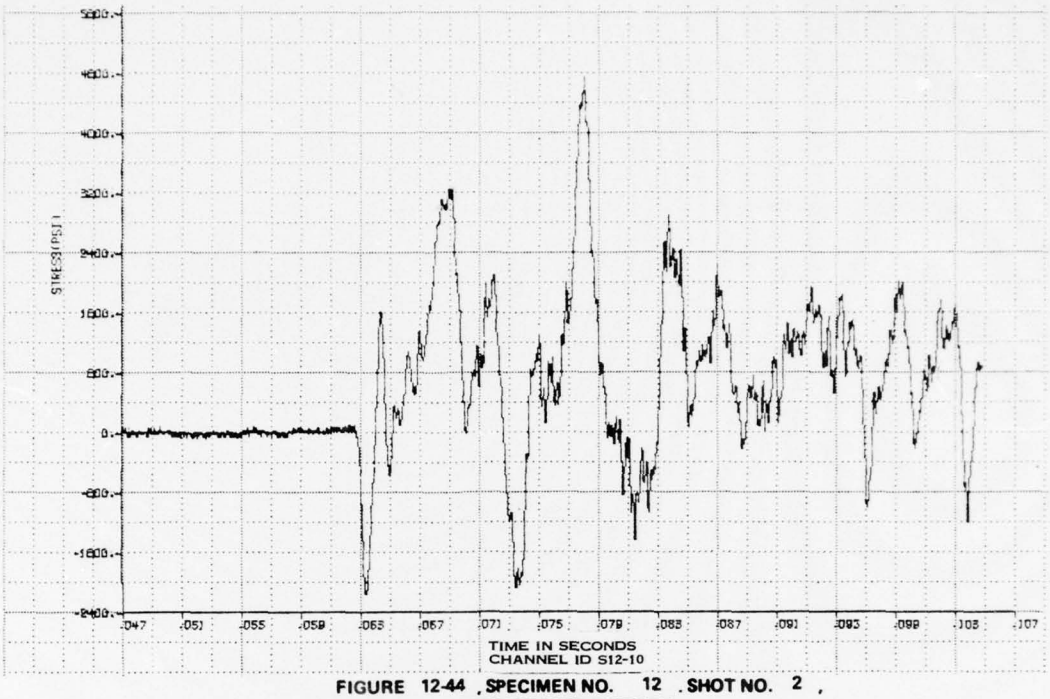


FIGURE 12-44 , SPECIMEN NO. 12 , SHOT NO. 2 ,
STRESS TIME HISTORY

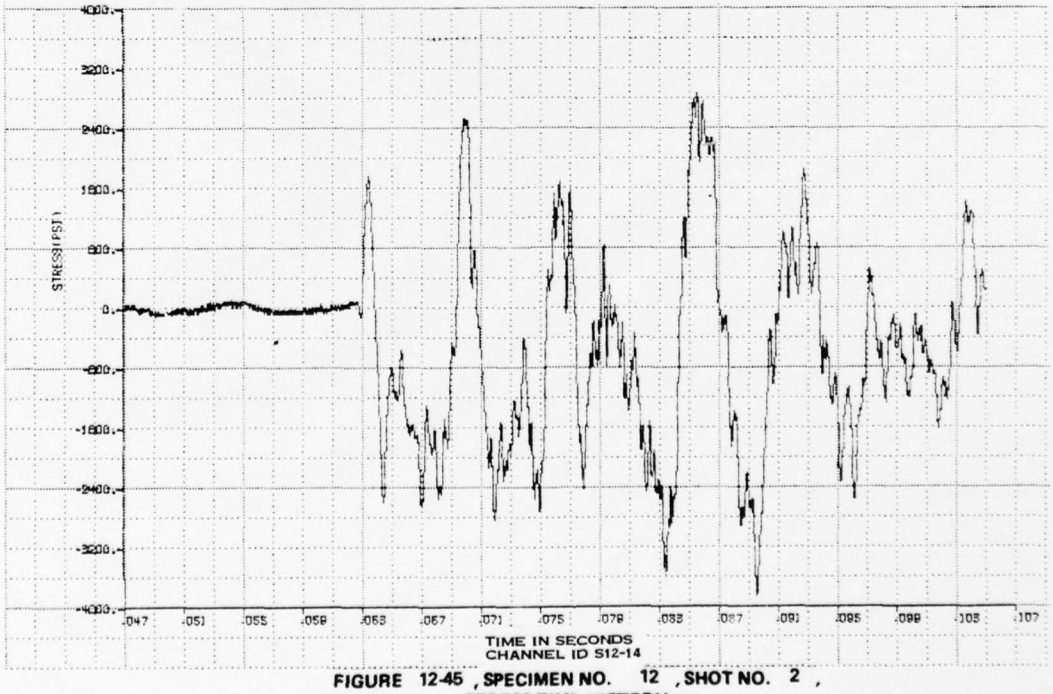


FIGURE 12-45 , SPECIMEN NO. 12 , SHOT NO. 2 ,
STRESS TIME HISTORY

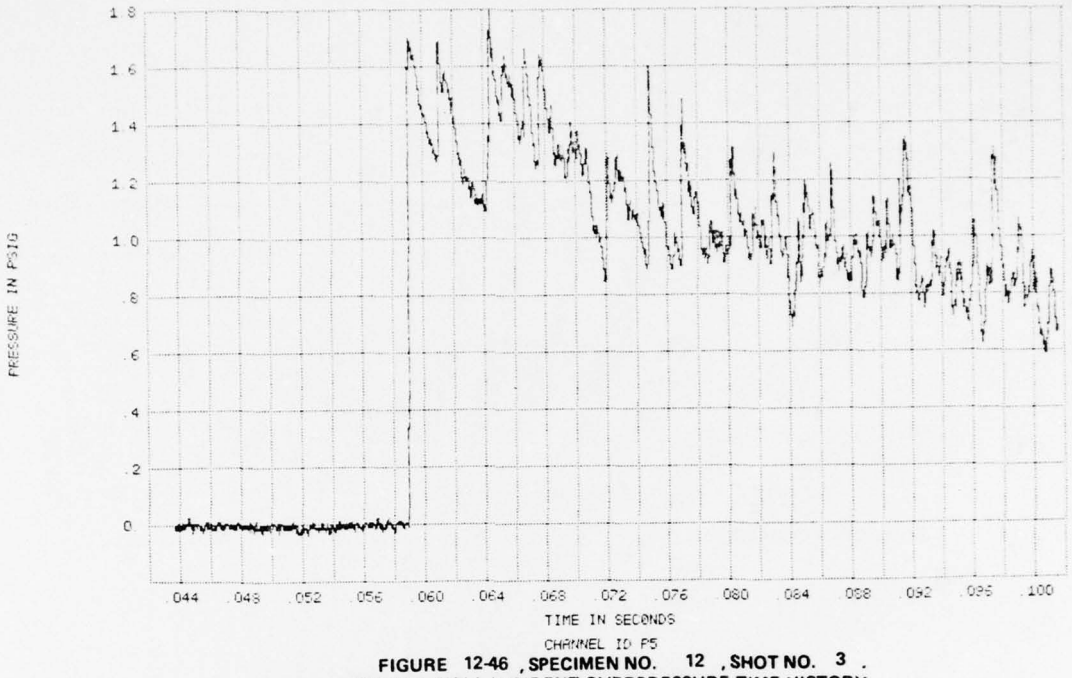


FIGURE 12-46 , SPECIMEN NO. 12 , SHOT NO. 3 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

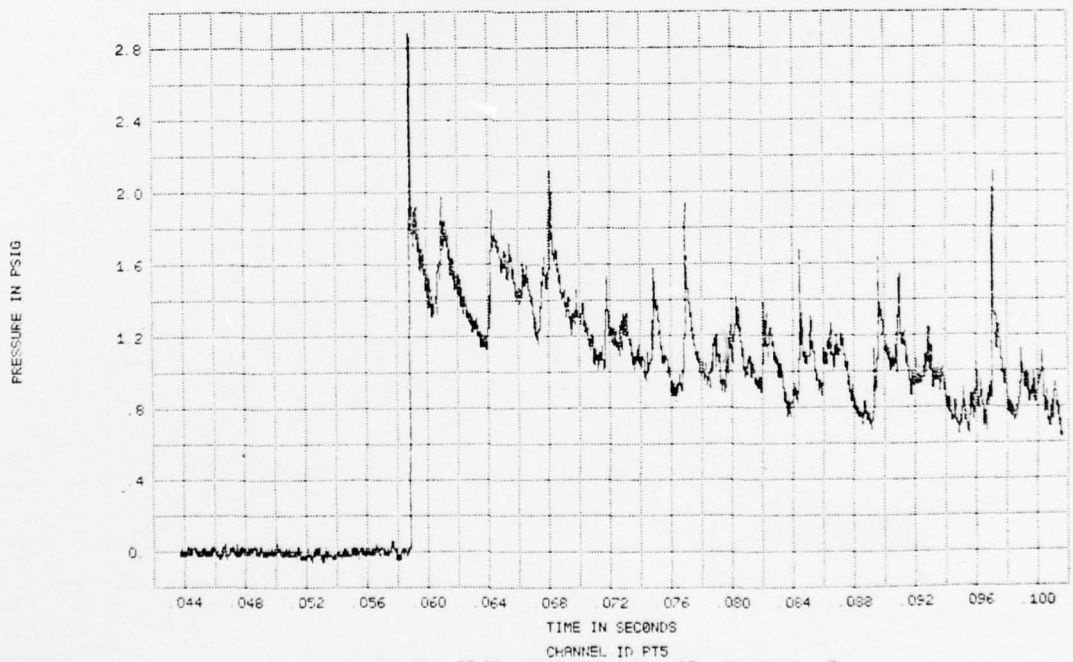


FIGURE 12-47 , SPECIMEN NO. 12 , SHOT NO. 3 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

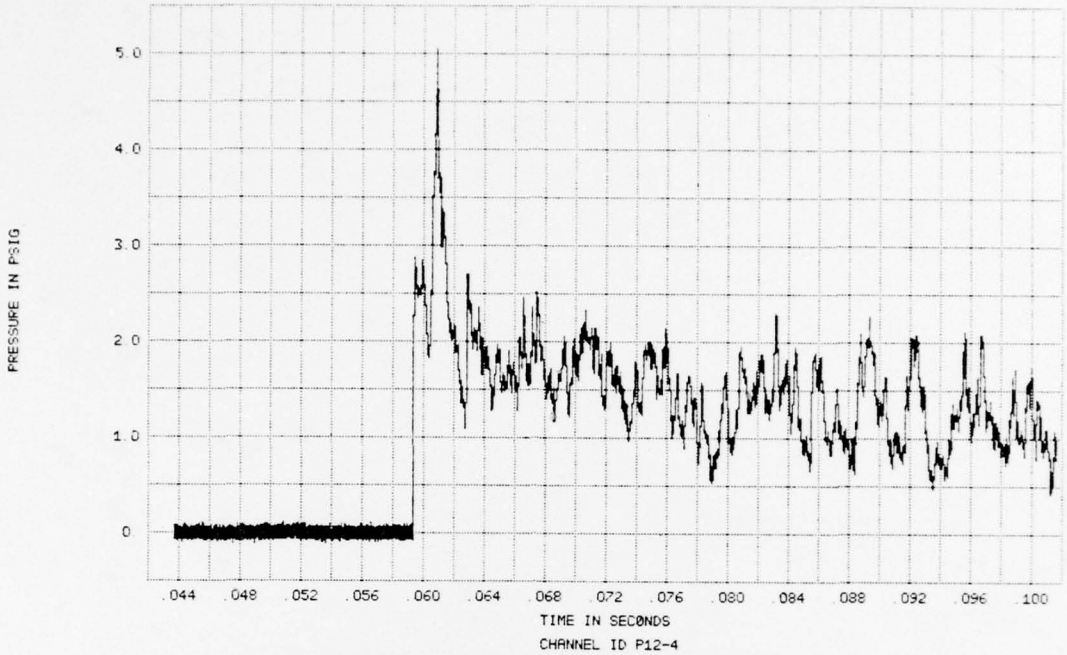


FIGURE 12-48 , SPECIMEN NO. 12 , SHOT NO. 3 , SPECIMEN REFLECTED PRESSURE TIME HISTORY

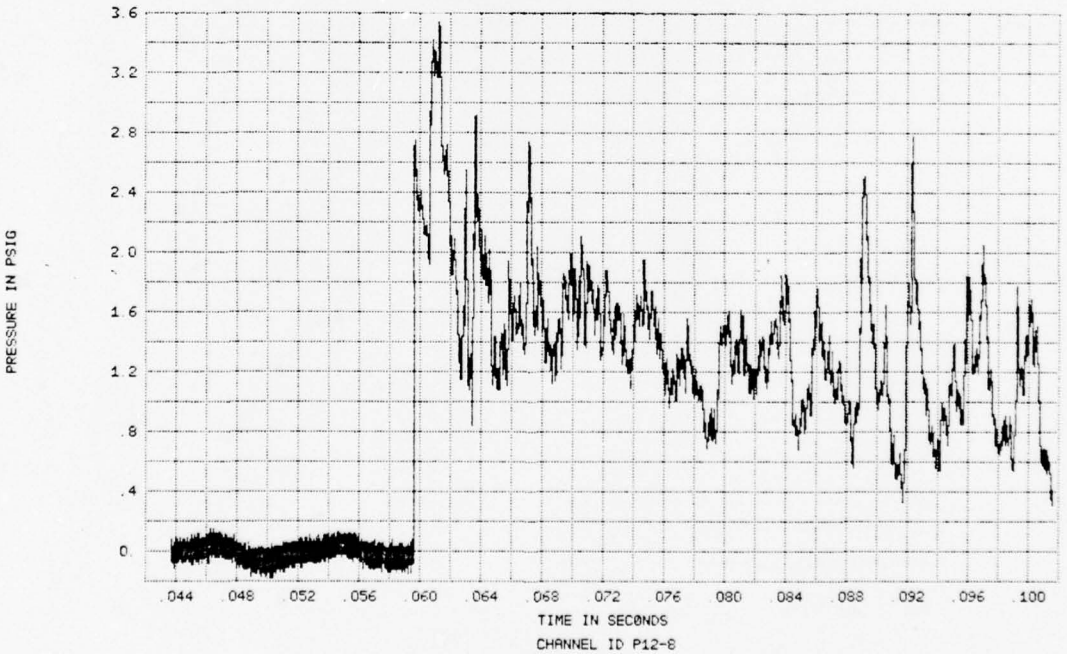


FIGURE 12-49 , SPECIMEN NO. 12 , SHOT NO. 3 , SPECIMEN REFLECTED PRESSURE TIME HISTORY

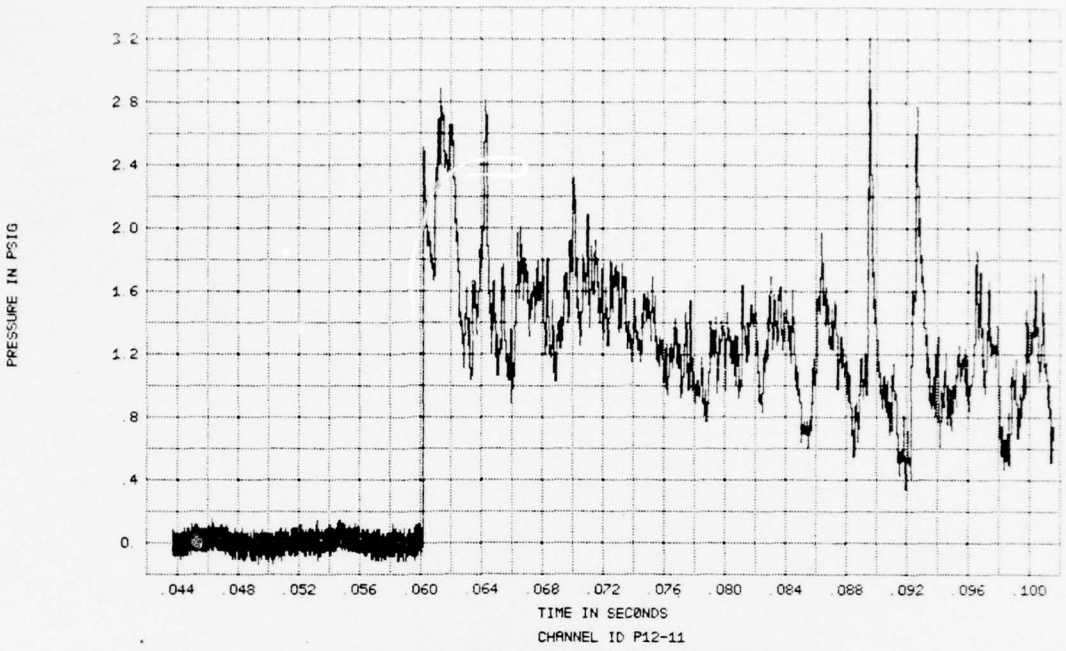


FIGURE 12-50 , SPECIMEN NO. 12 , SHOT NO. 3 , SPECIMEN REFLECTED PRESSURE TIME HISTORY

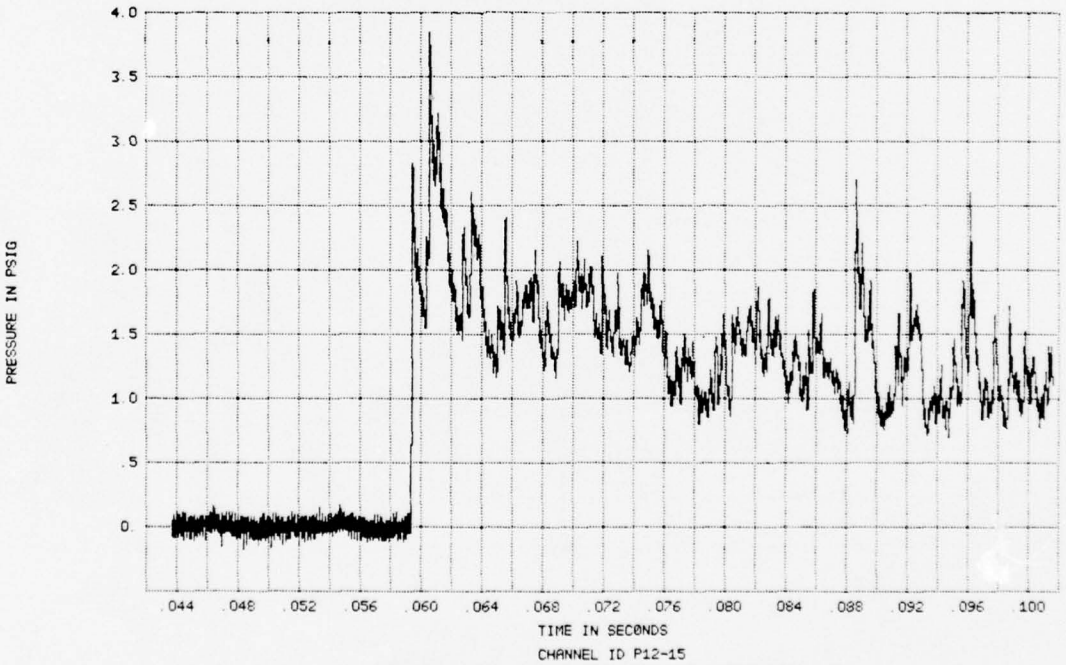


FIGURE 12-51 , SPECIMEN NO. 12 , SHOT NO. 3 , SPECIMEN REFLECTED PRESSURE TIME HISTORY

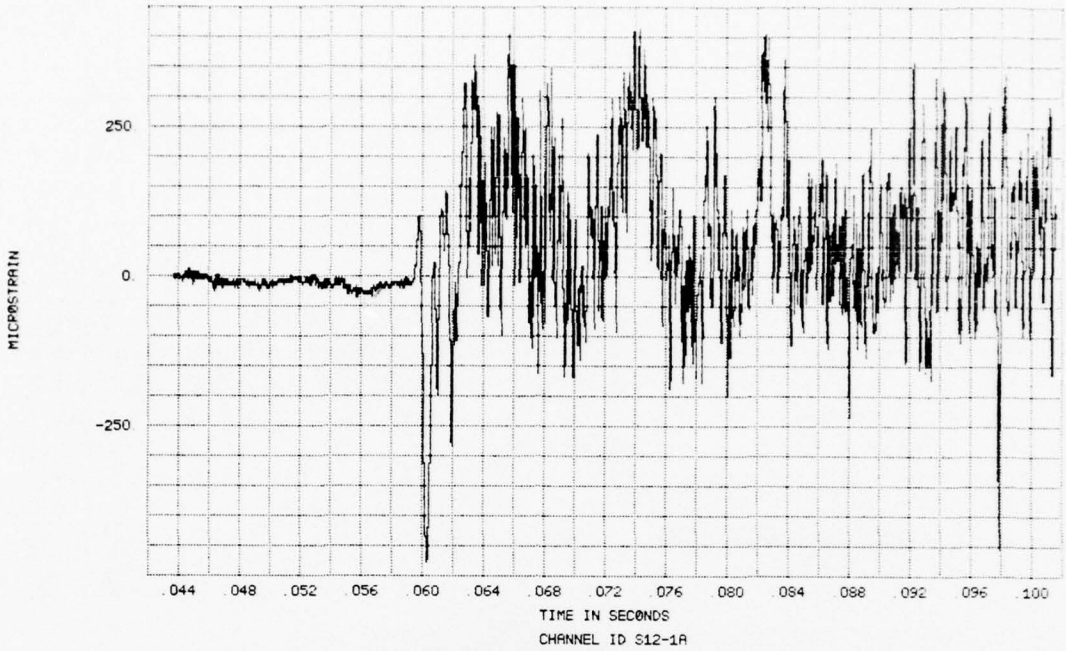


FIGURE 12-52 , SPECIMEN NO. 12 , SHOT NO. 3 , STRAIN TIME HISTORY

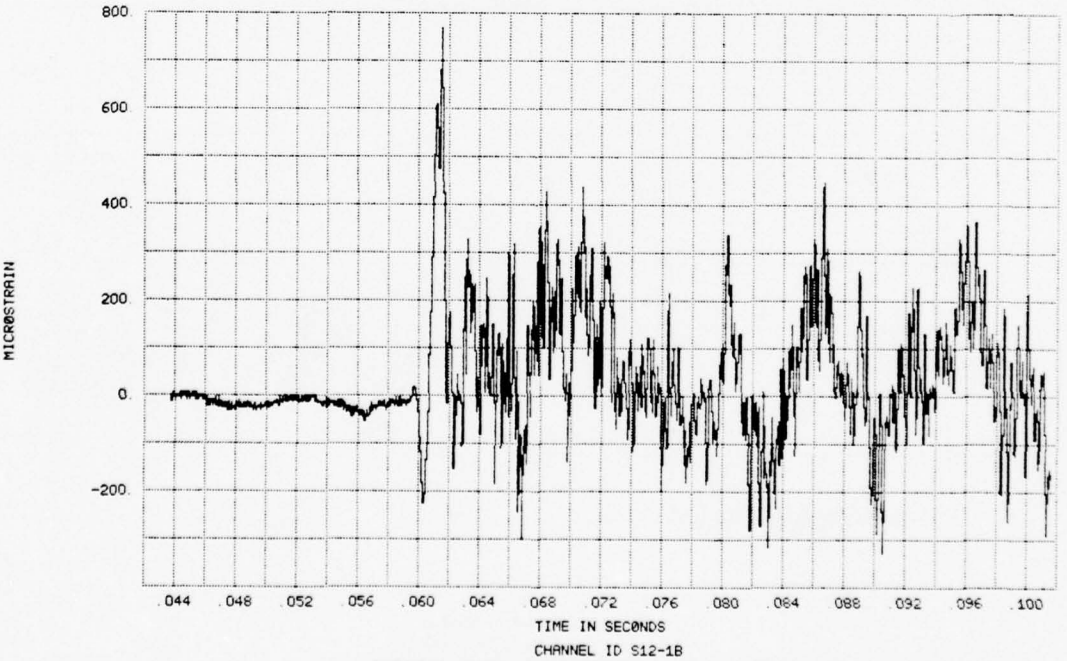


FIGURE 12-53 , SPECIMEN NO. 12 , SHOT NO. 3 , STRAIN TIME HISTORY

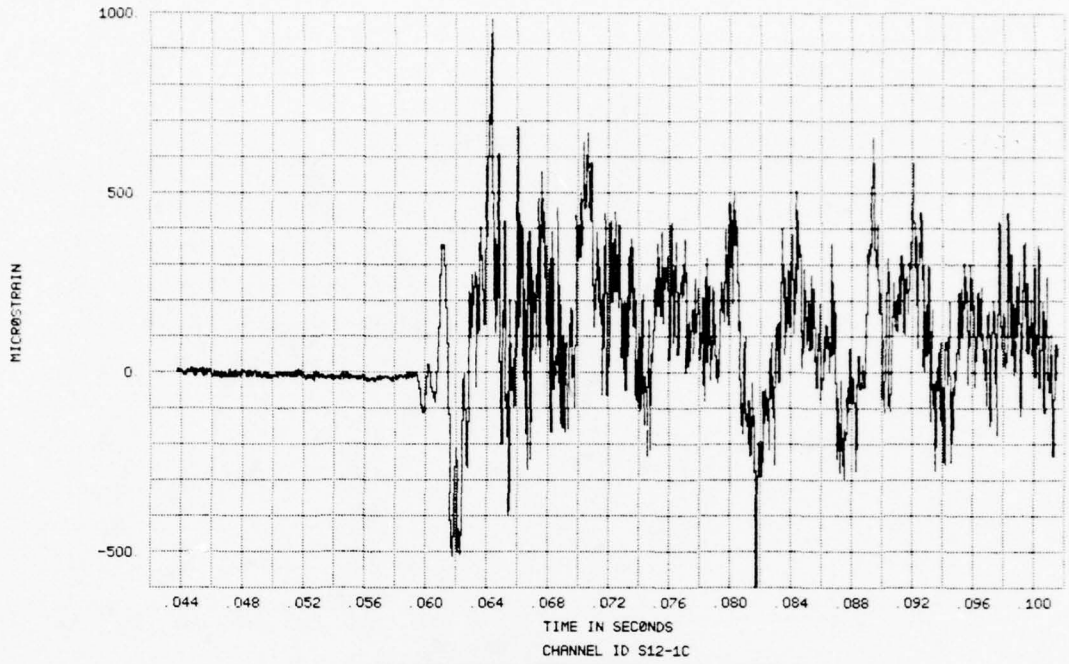


FIGURE 12-54 , SPECIMEN NO. 12 , SHOT NO. 3 , STRAIN TIME HISTORY

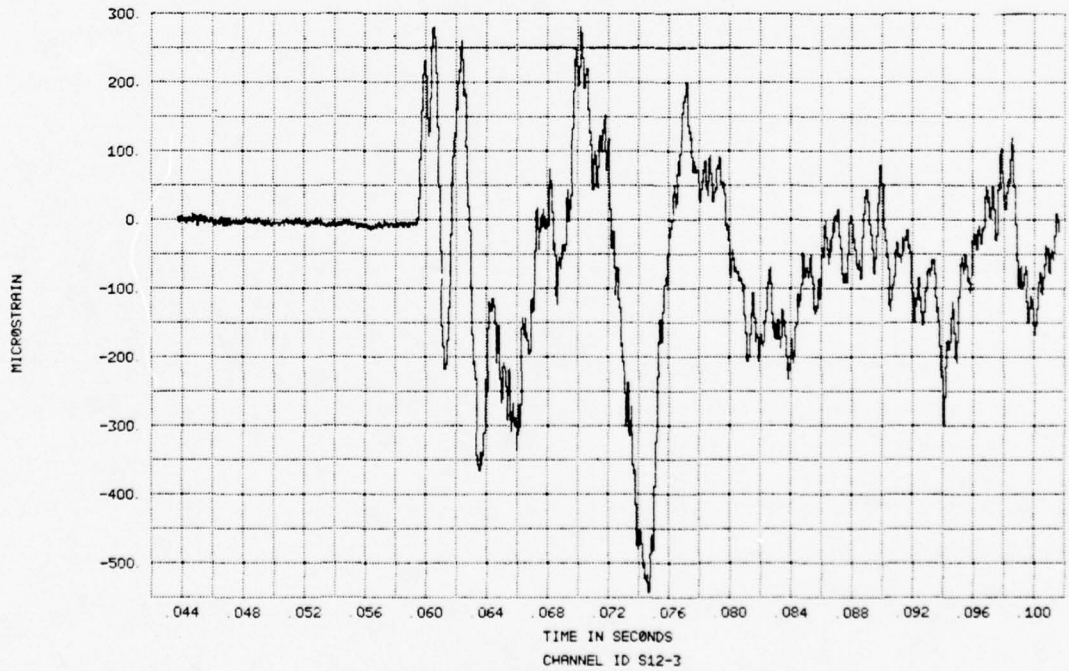


FIGURE 12-55 , SPECIMEN NO. 12 , SHOT NO. 3 , STRAIN TIME HISTORY

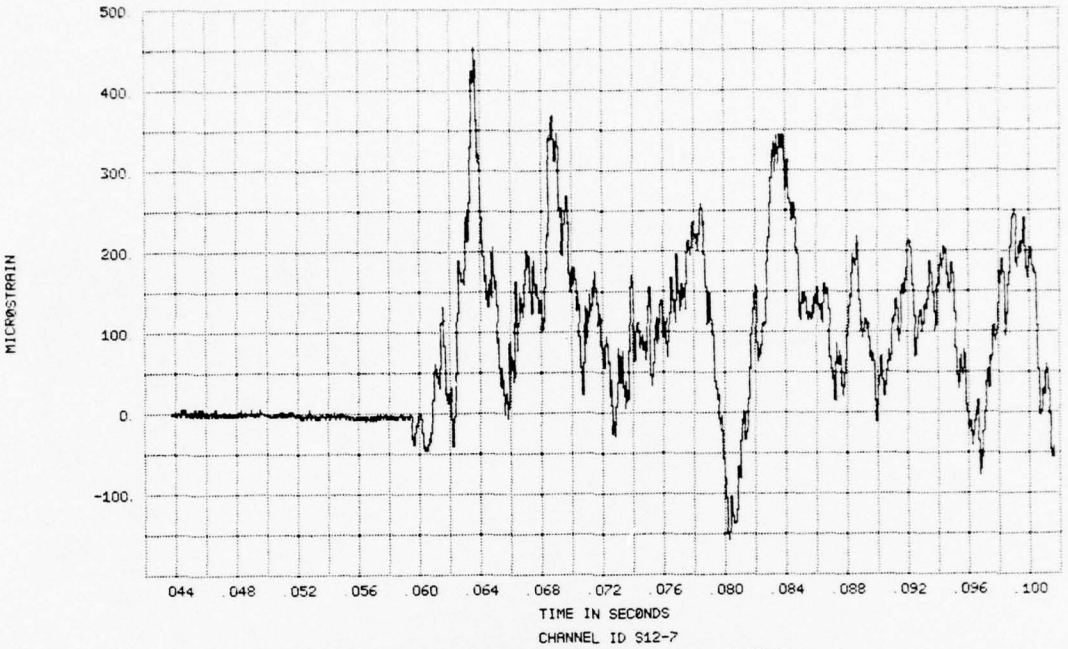


FIGURE 12-56 , SPECIMEN NO. 12 , SHOT NO. 3 , STRAIN TIME HISTORY

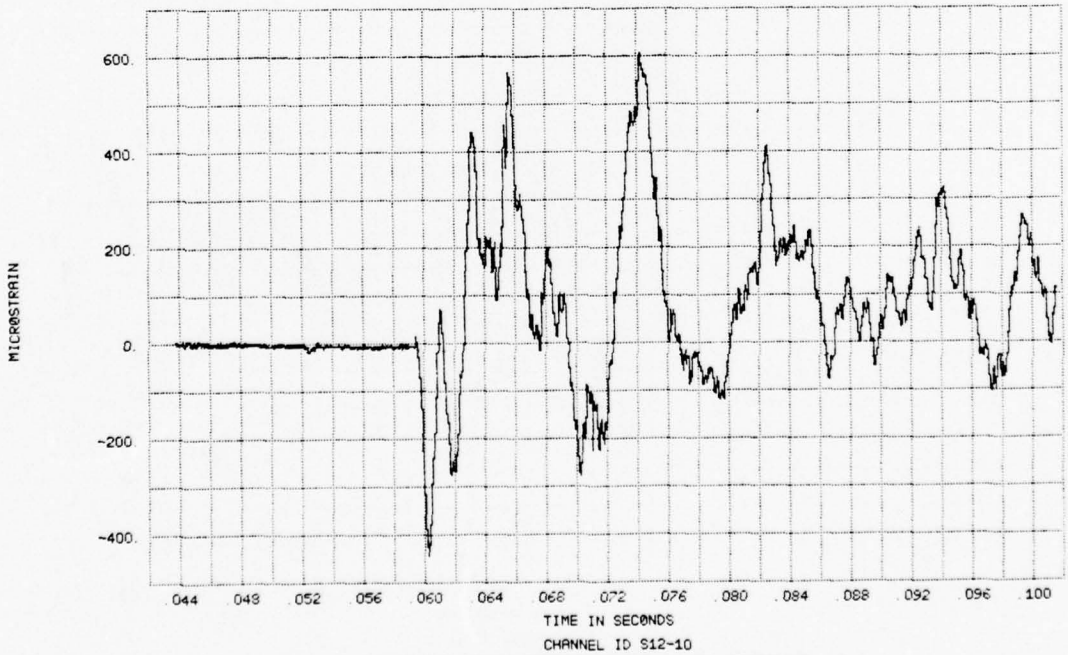


FIGURE 12-57 , SPECIMEN NO. 12 , SHOT NO. 3 , STRAIN TIME HISTORY

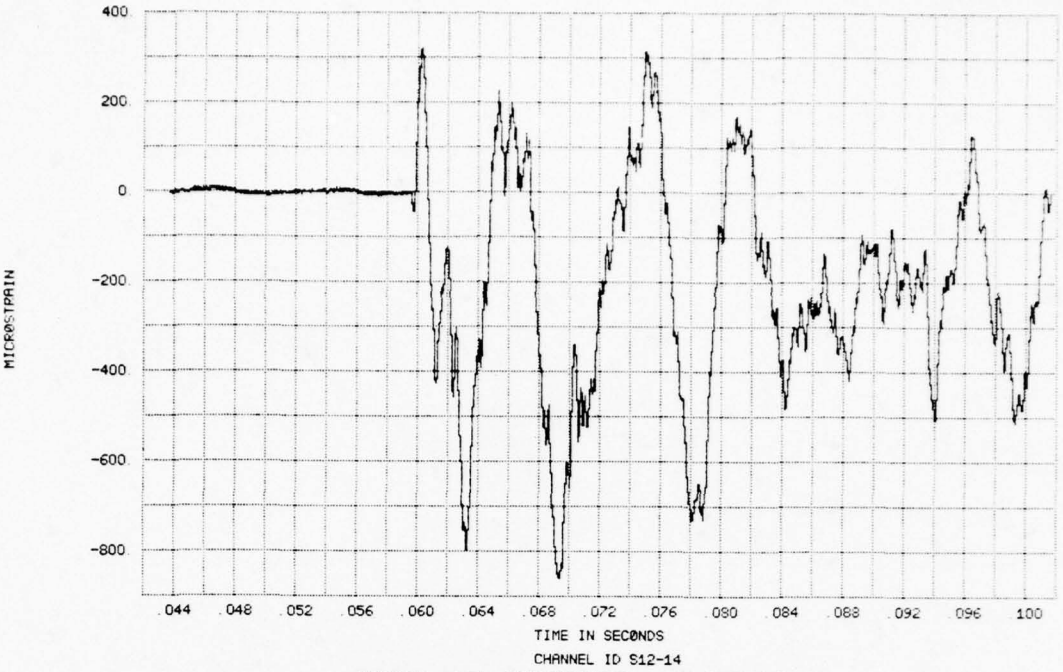


FIGURE 12-58 , SPECIMEN NO. 12 , SHOT NO. 3 , STRAIN TIME HISTORY

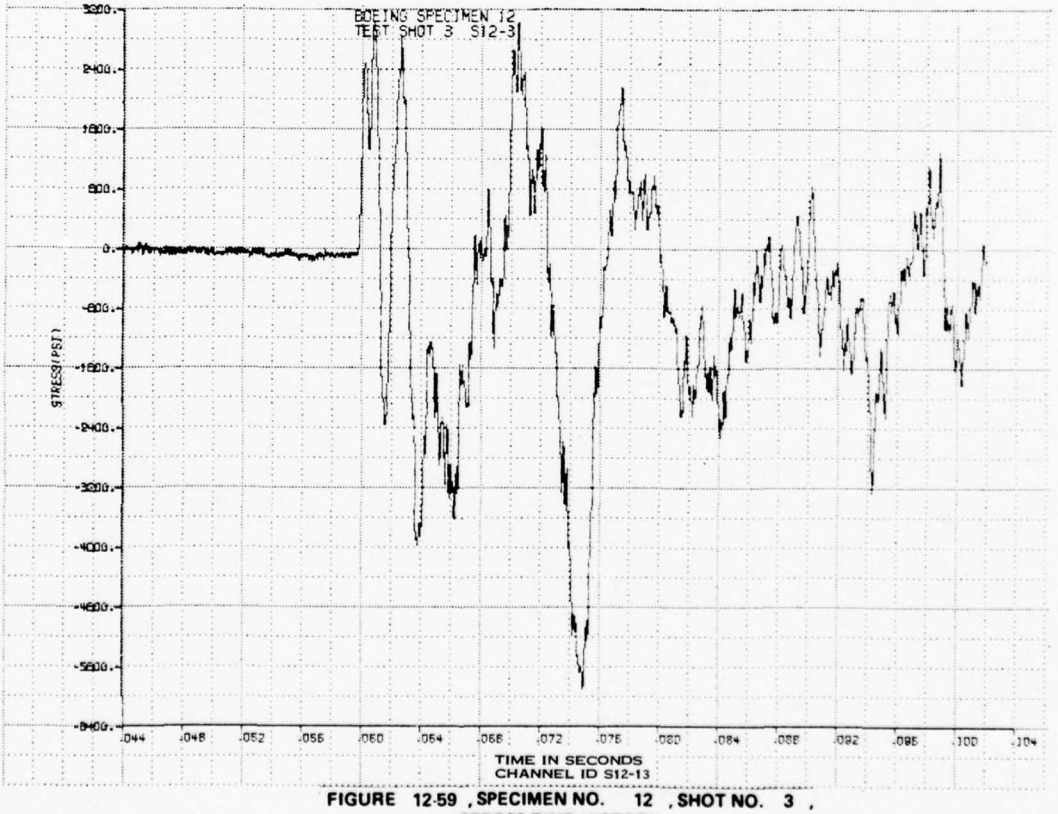


FIGURE 12-59 , SPECIMEN NO. 12 , SHOT NO. 3 , STRESS TIME HISTORY

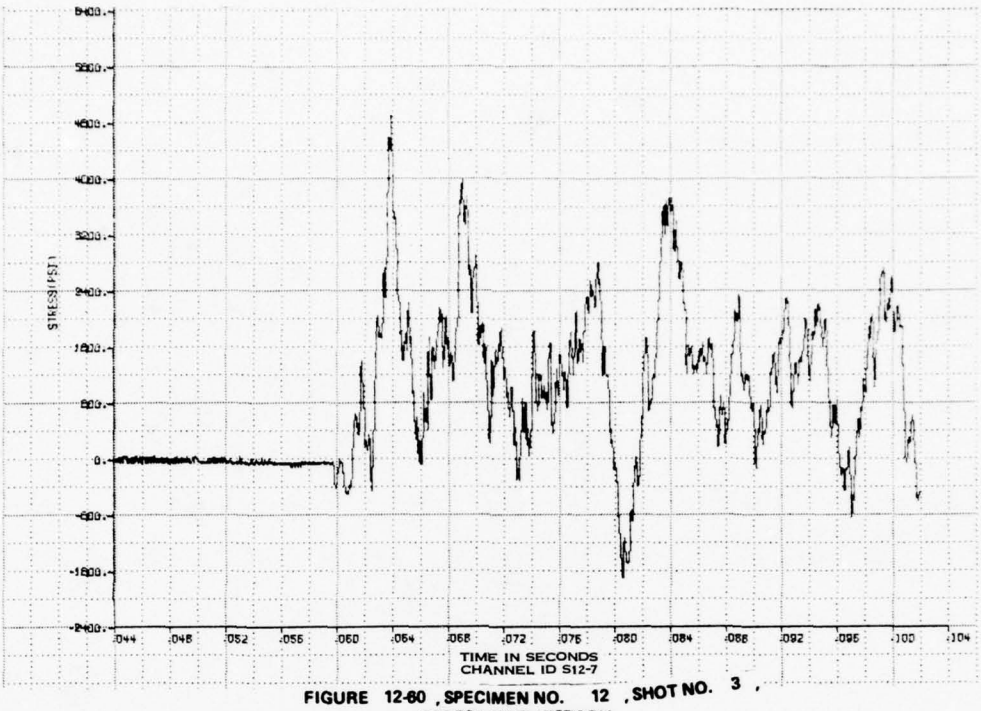


FIGURE 12-60 , SPECIMEN NO. 12 , SHOT NO. 3 ,
STRESS TIME HISTORY

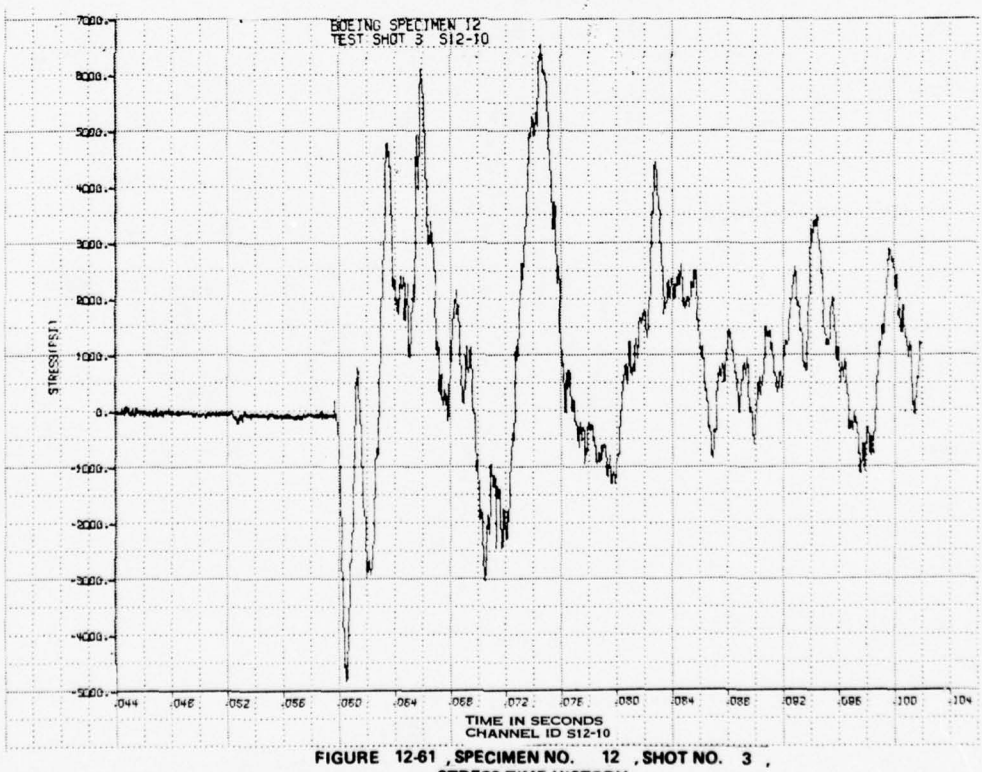


FIGURE 12-61 , SPECIMEN NO. 12 , SHOT NO. 3 ,
STRESS TIME HISTORY

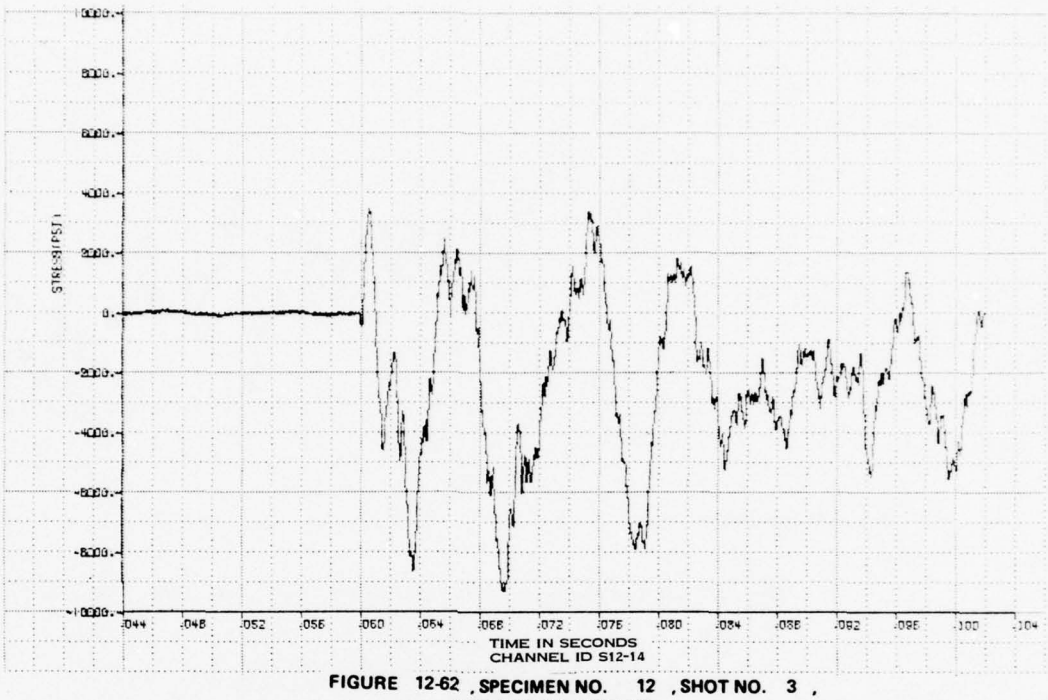


FIGURE 12-62 , SPECIMEN NO. 12 , SHOT NO. 3 ,
STRESS TIME HISTORY

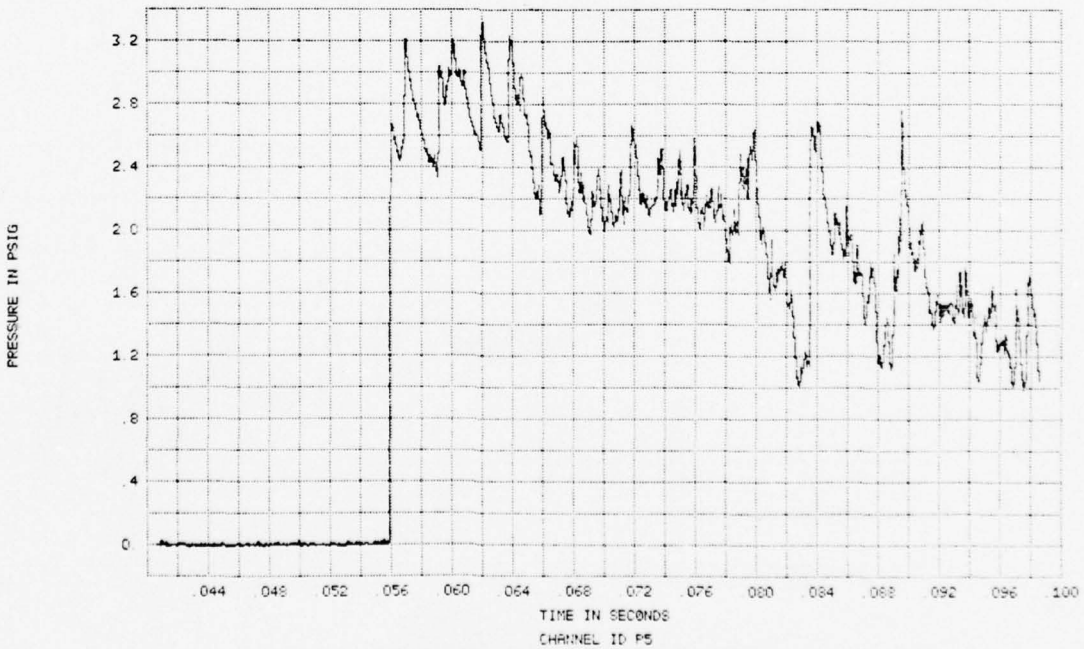


FIGURE 12-63 , SPECIMEN NO. 12 , SHOT NO. 4 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

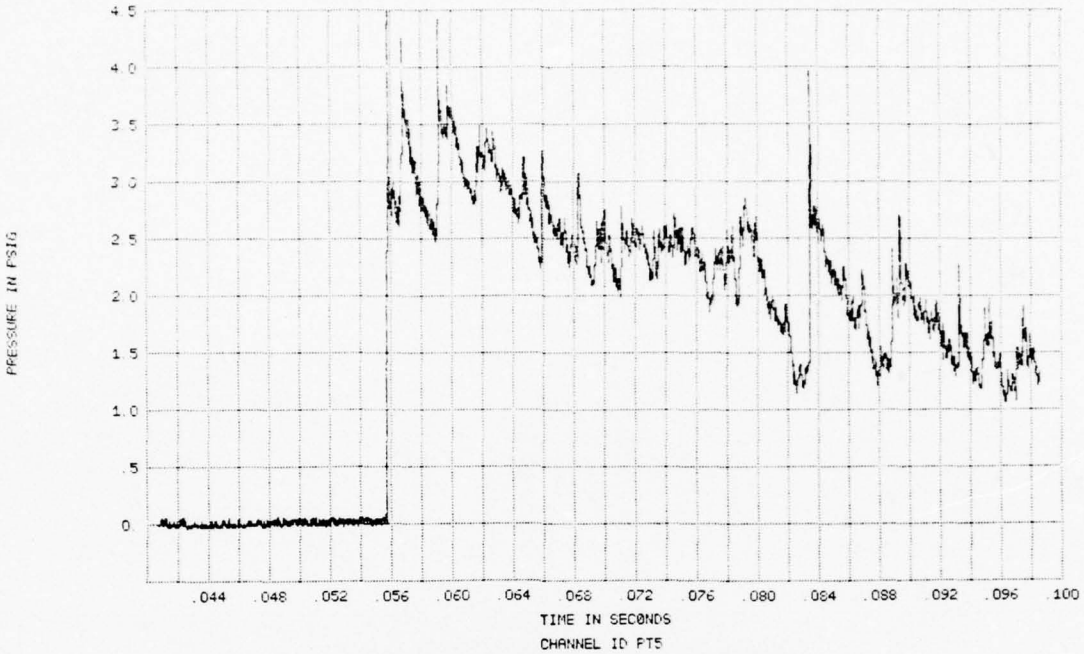


FIGURE 12-64 , SPECIMEN NO. 12 , SHOT NO. 4 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

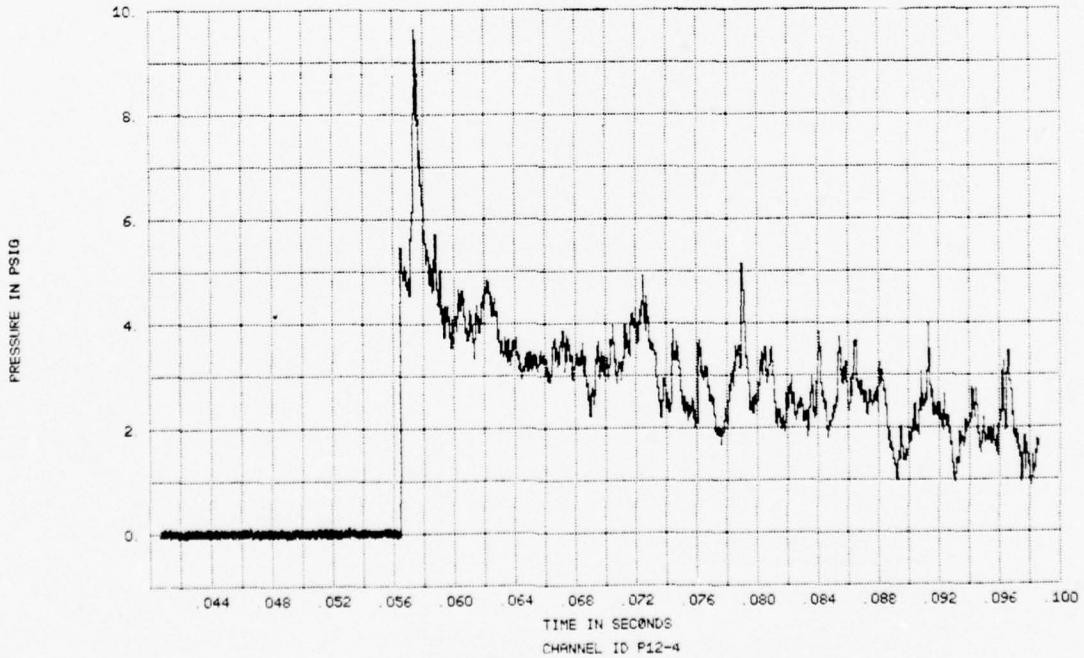


FIGURE 12-65 , SPECIMEN NO. 12 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

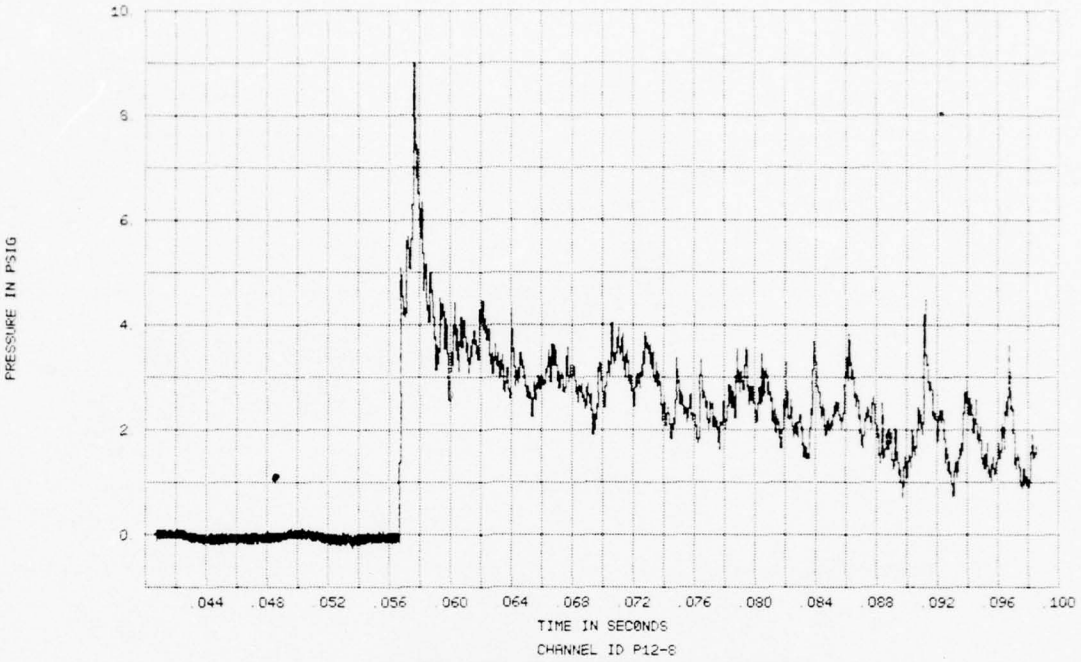


FIGURE 12-66 , SPECIMEN NO. 12 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

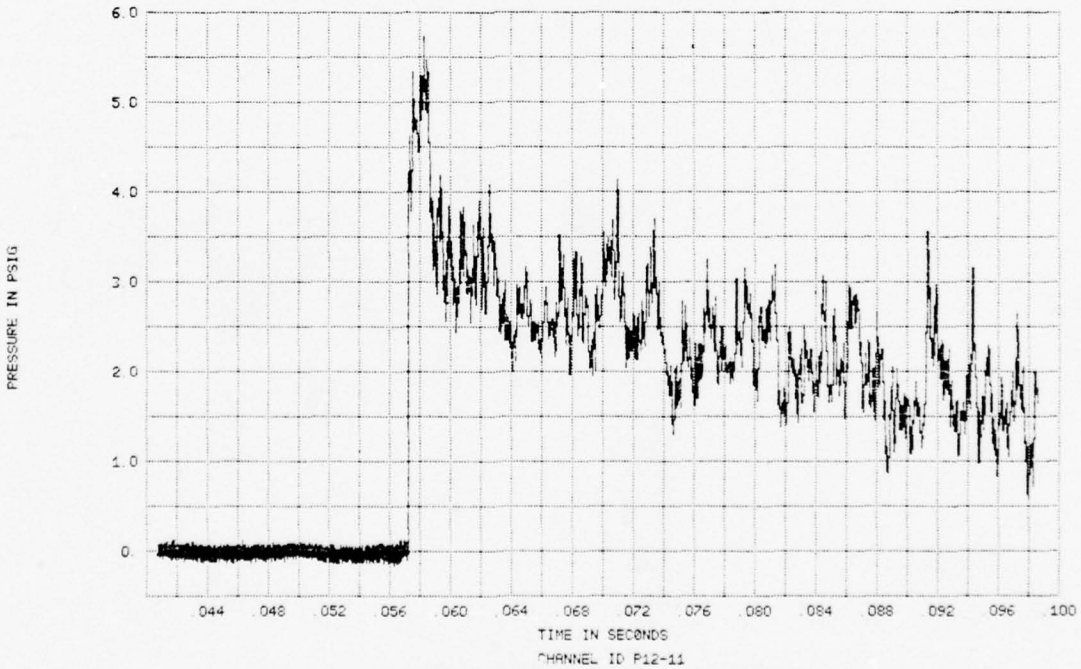


FIGURE 12-67 , SPECIMEN NO. 12 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

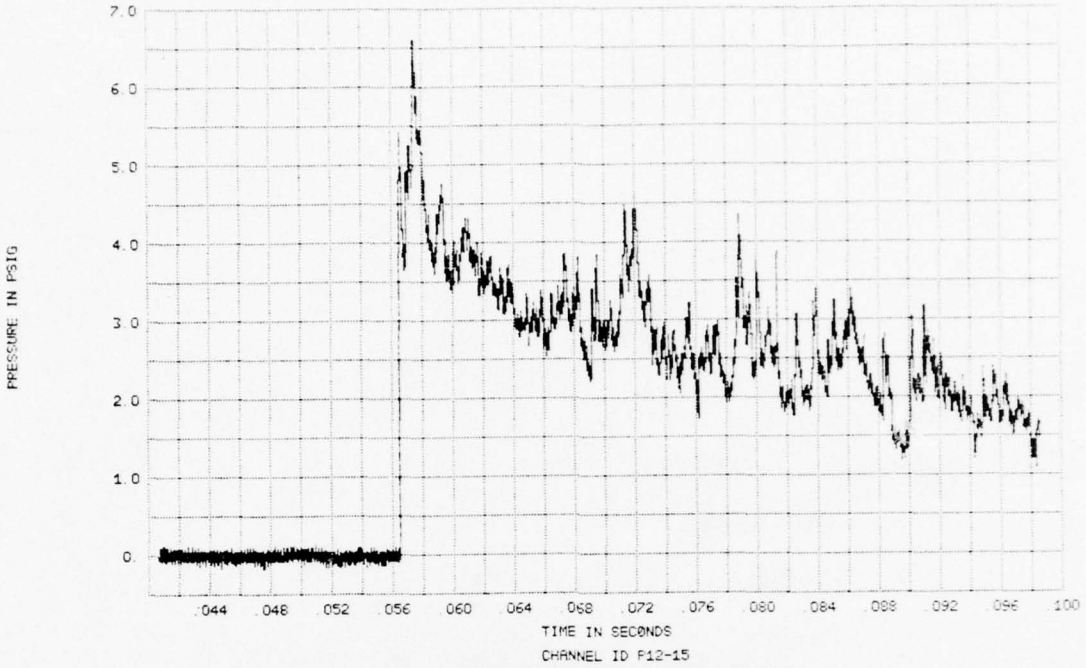


FIGURE 12-68 , SPECIMEN NO. 12 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

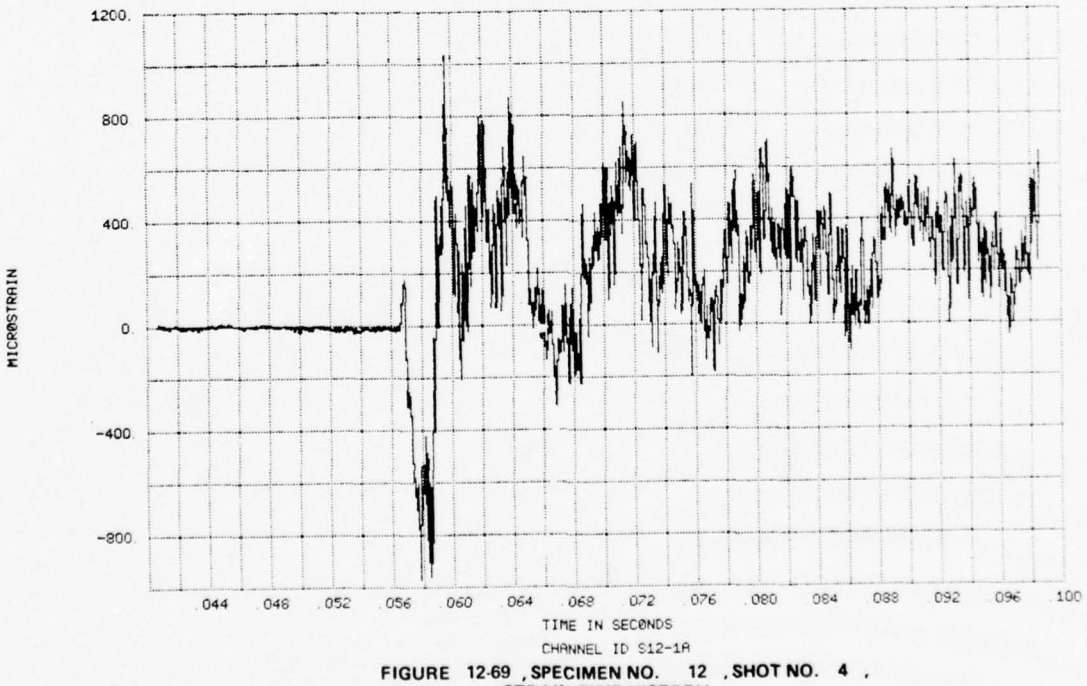


FIGURE 12-69 , SPECIMEN NO. 12 , SHOT NO. 4 ,
STRAIN TIME HISTORY

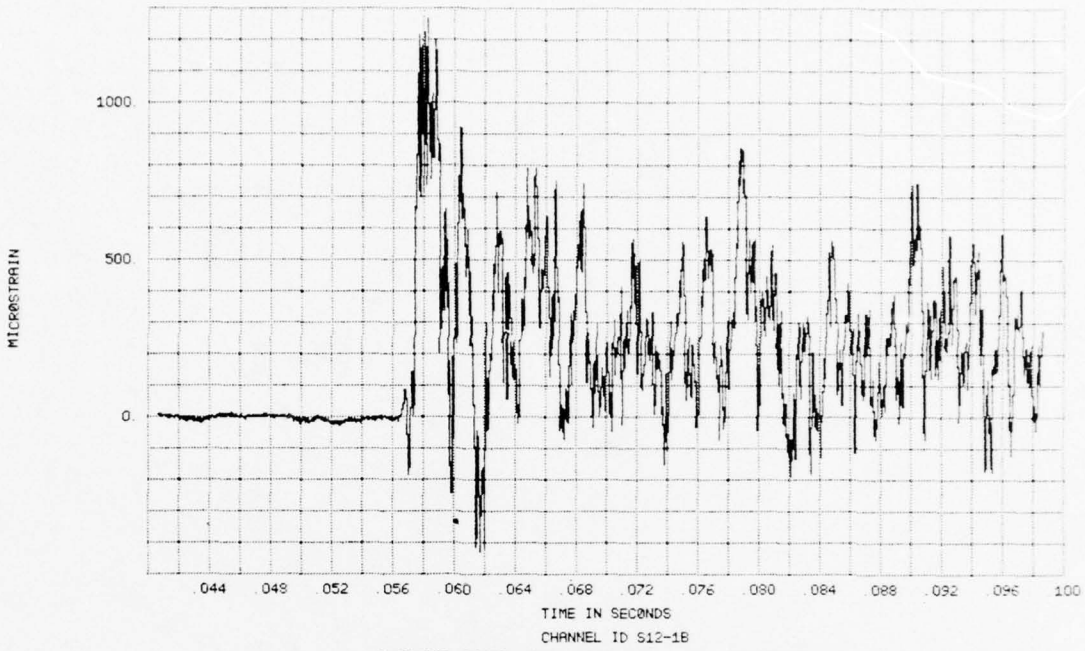


FIGURE 12-70 , SPECIMEN NO. 12 , SHOT NO. 4 , STRAIN TIME HISTORY

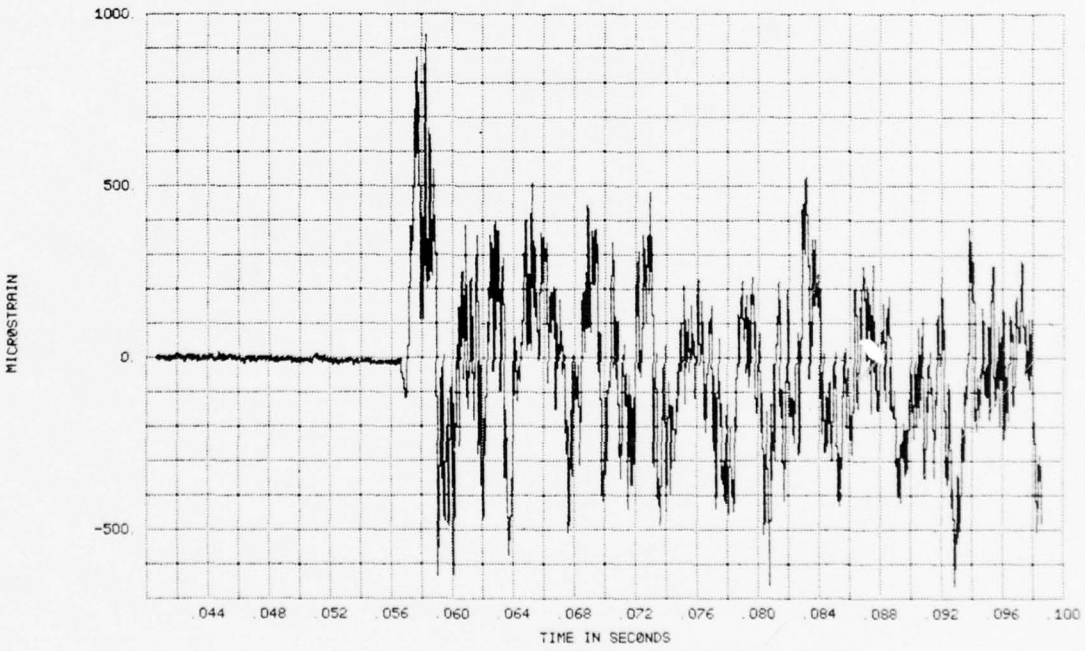


FIGURE 12-71 , SPECIMEN NO. 12 , SHOT NO. 4 , STRAIN TIME HISTORY

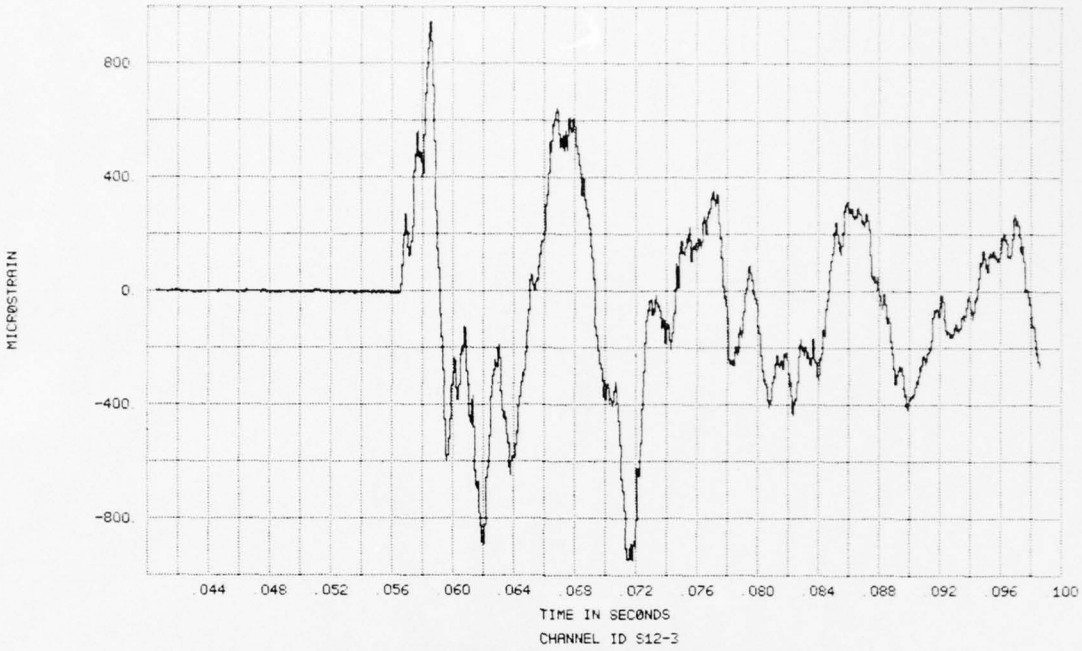


FIGURE 12-72 , SPECIMEN NO. 12 , SHOT NO. 4 , STRAIN TIME HISTORY

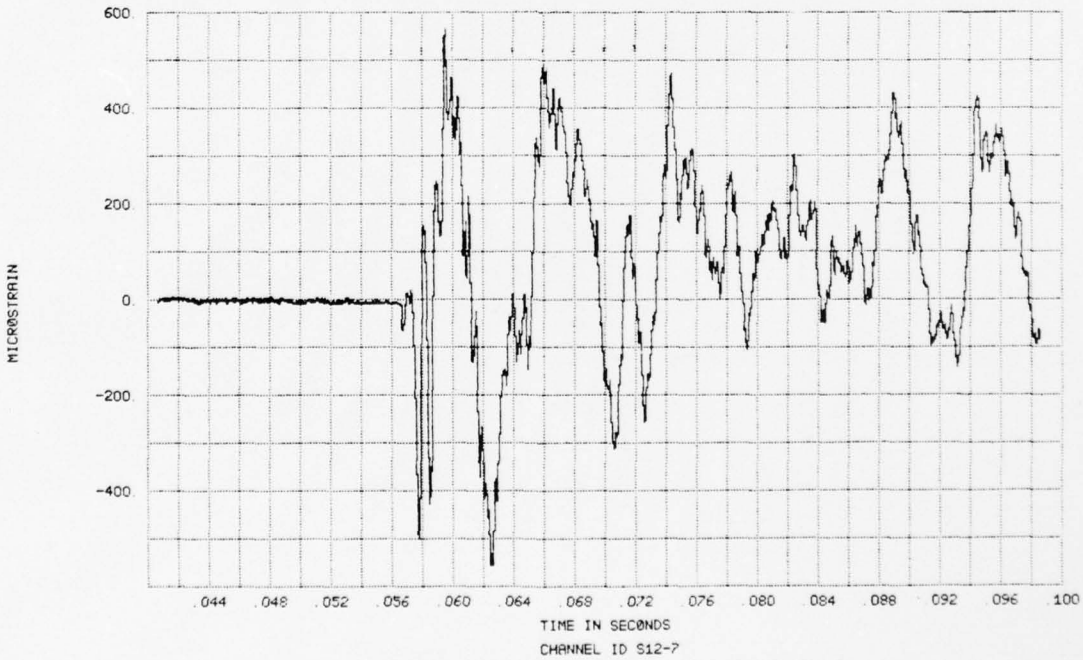


FIGURE 12-73 , SPECIMEN NO. 12 , SHOT NO. 4 , STRAIN TIME HISTORY

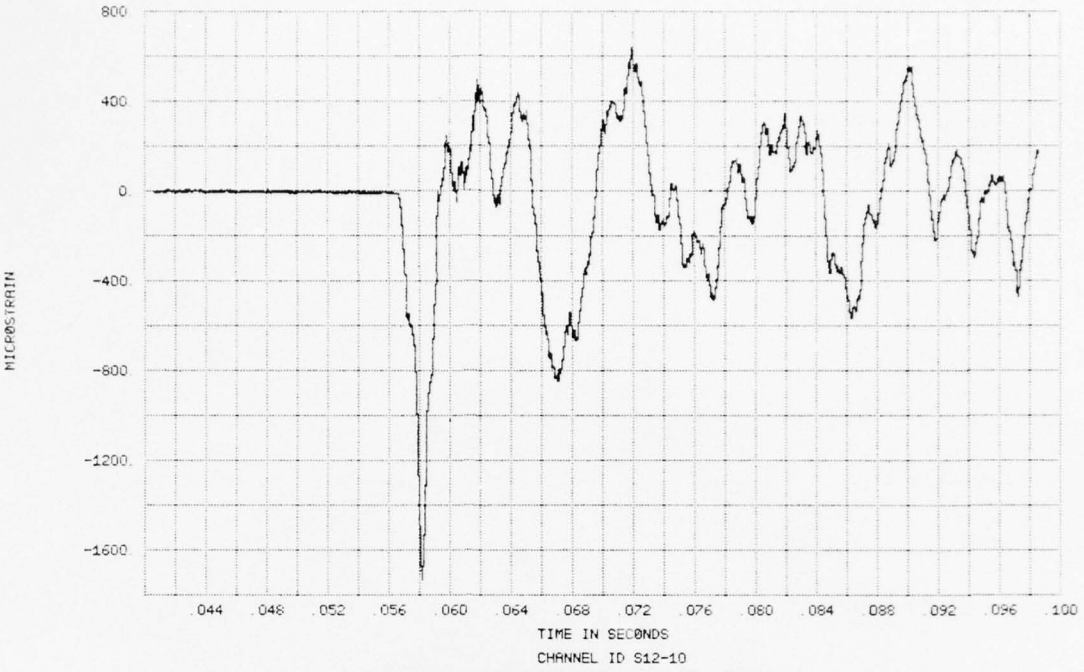


FIGURE 12-74 , SPECIMEN NO. 12 , SHOT NO. 4 , STRAIN TIME HISTORY

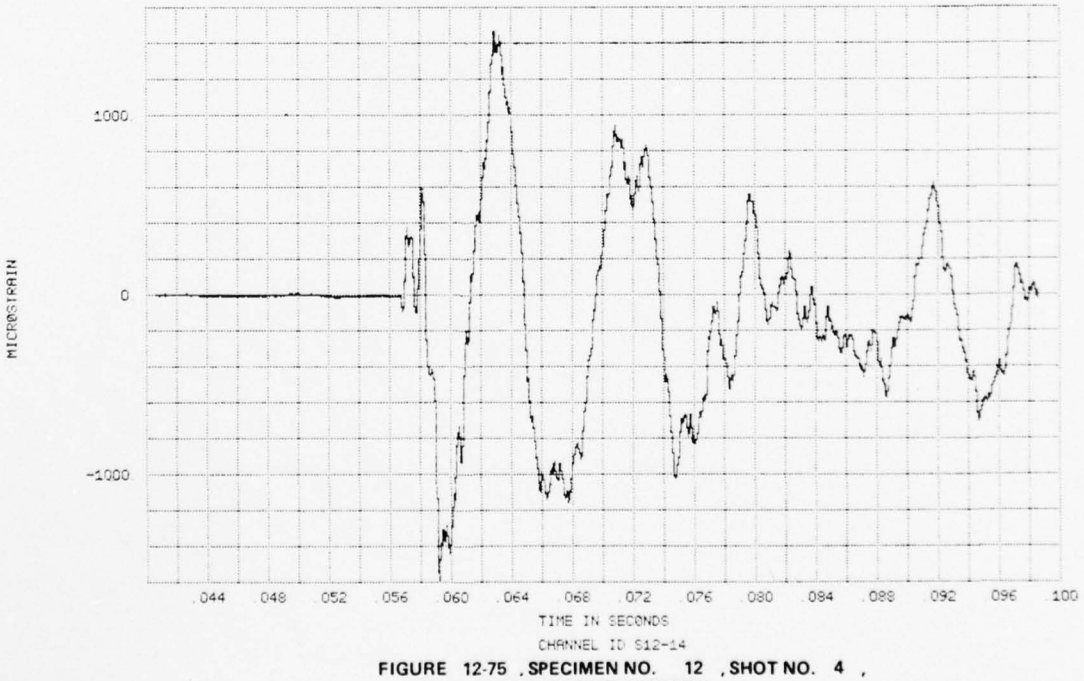


FIGURE 12-75 , SPECIMEN NO. 12 , SHOT NO. 4 , STRAIN TIME HISTORY

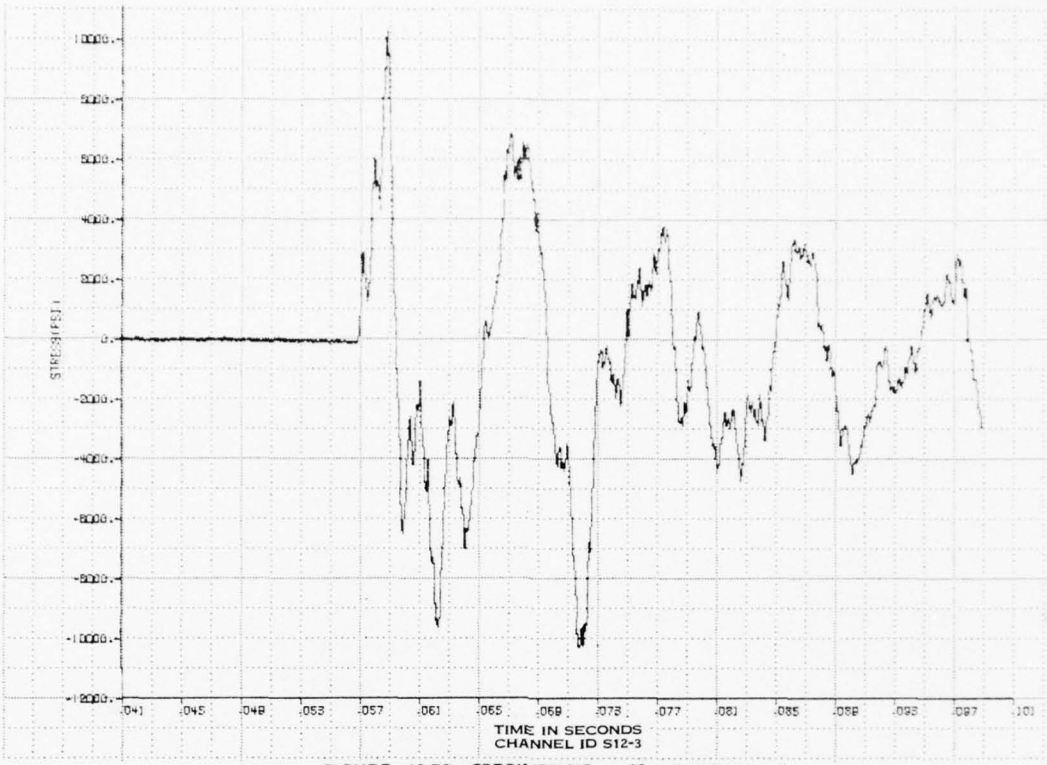


FIGURE 12-76 , SPECIMEN NO. 12 , SHOT NO. 4 ,
STRESS TIME HISTORY

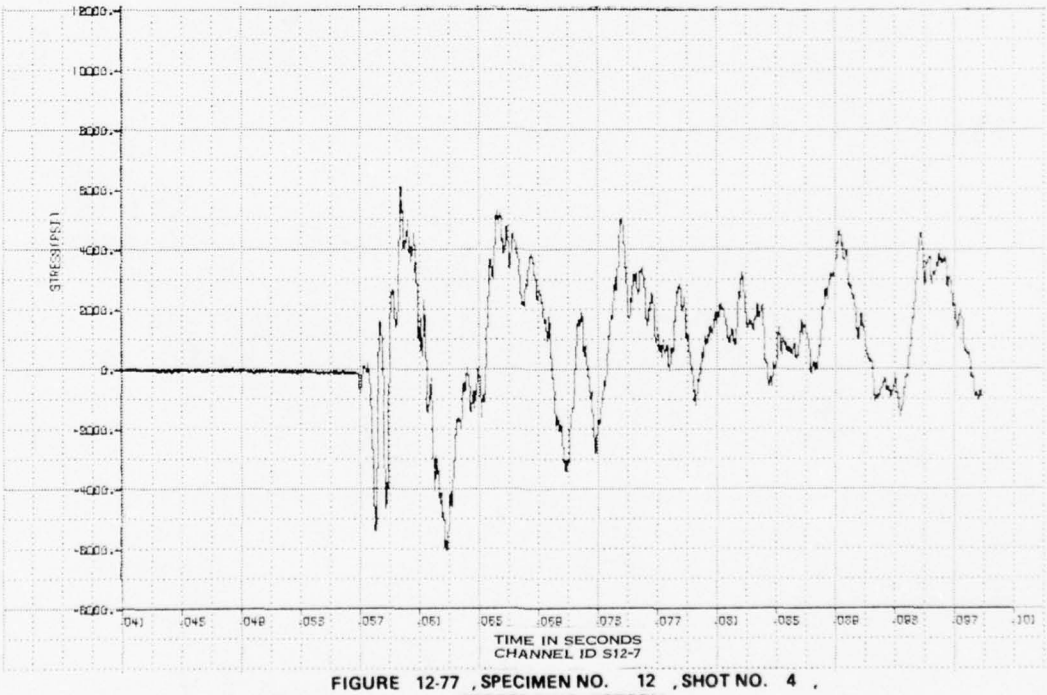


FIGURE 12-77 , SPECIMEN NO. 12 , SHOT NO. 4 ,
STRESS TIME HISTORY

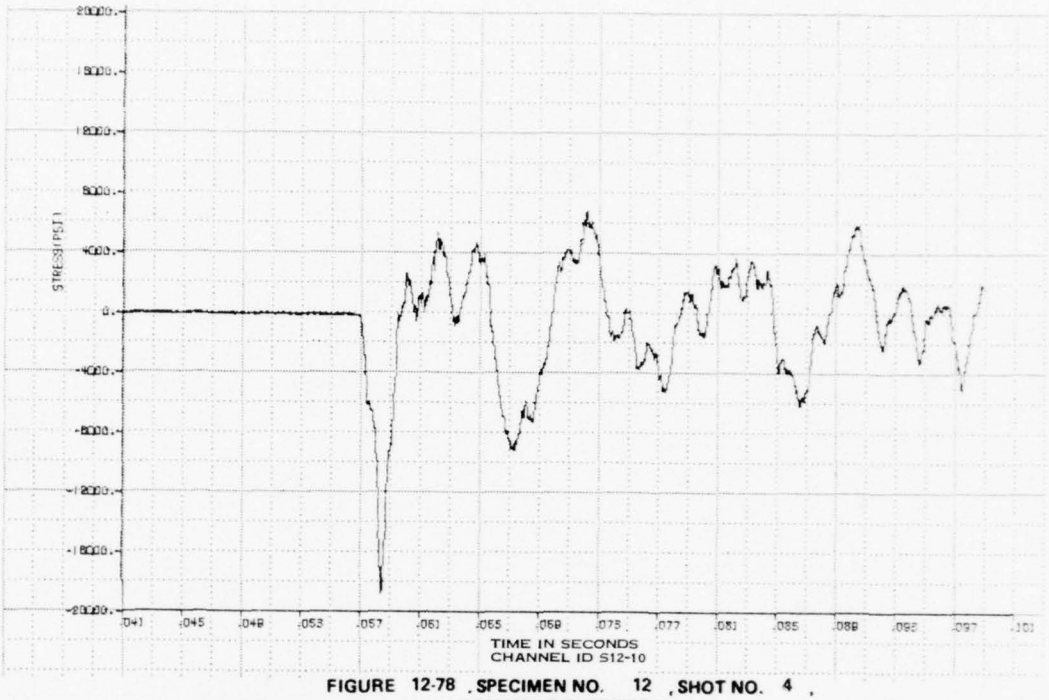


FIGURE 12-78 , SPECIMEN NO. 12 , SHOT NO. 4 ,
STRESS TIME HISTORY

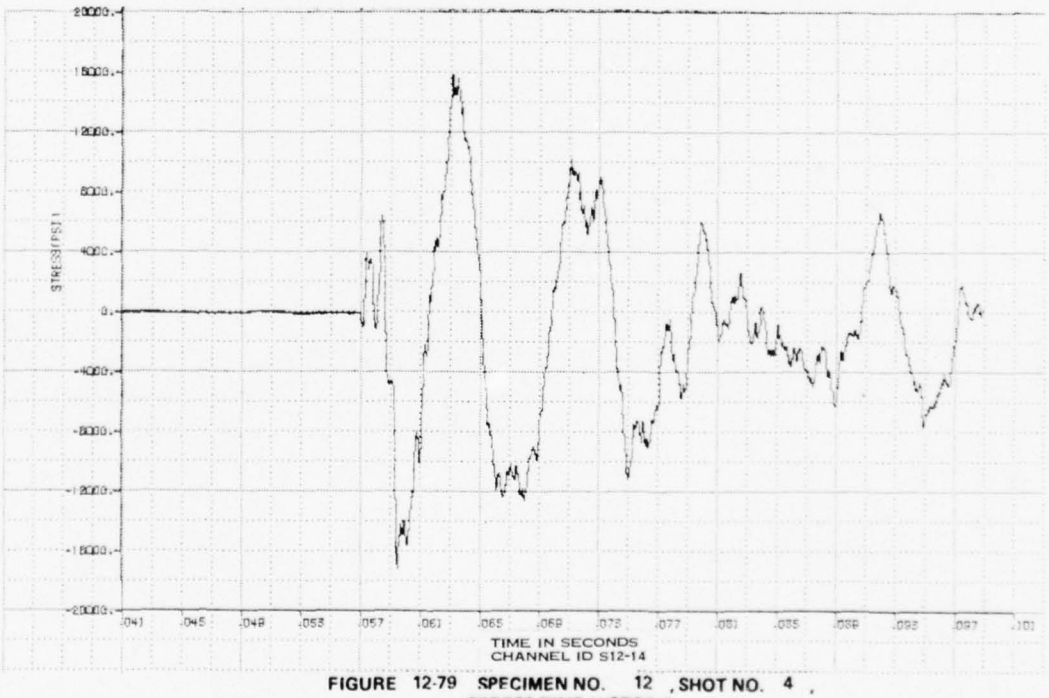


FIGURE 12-79 SPECIMEN NO. 12 , SHOT NO. 4 ,
STRESS TIME HISTORY

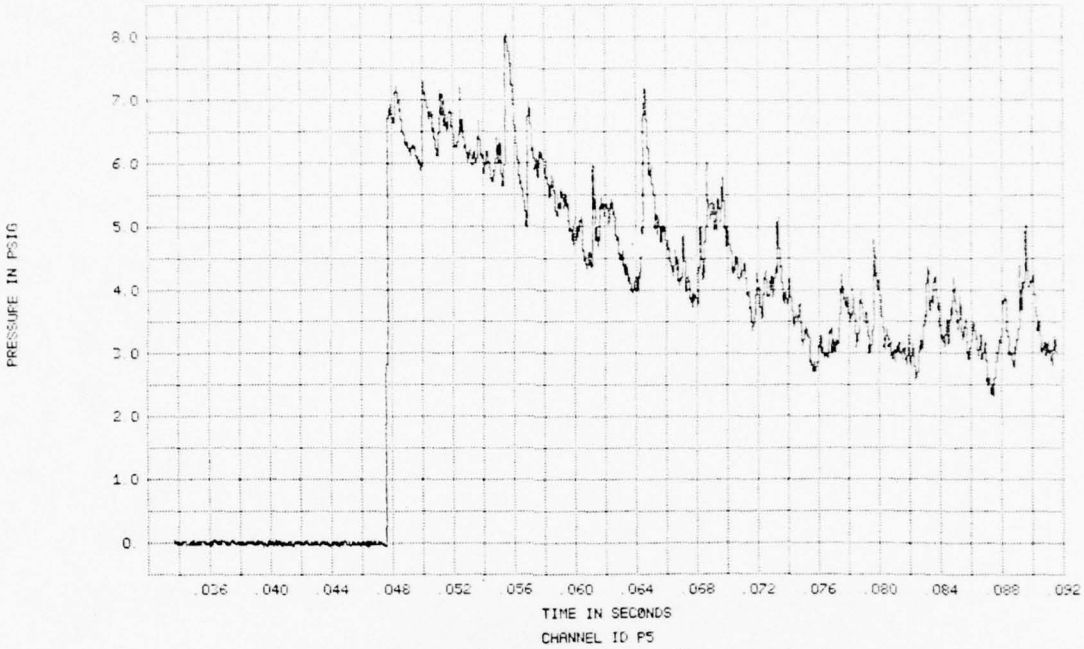


FIGURE 12-80 , SPECIMEN NO. 12 , SHOT NO. 5 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

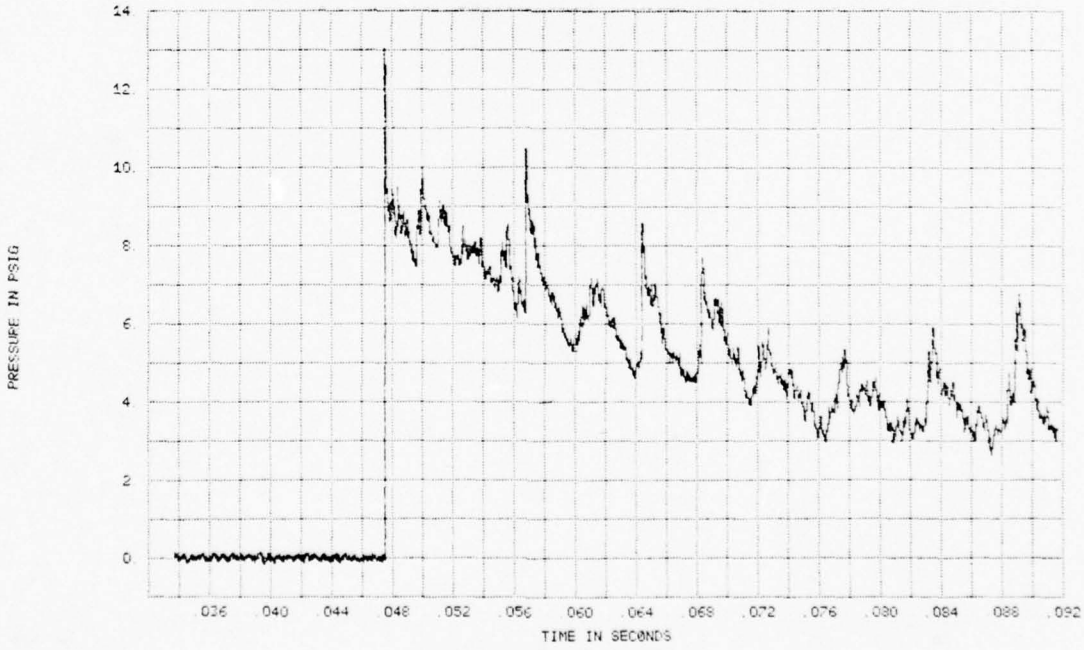


FIGURE 12-81 , SPECIMEN NO. 12 , SHOT NO. 5 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

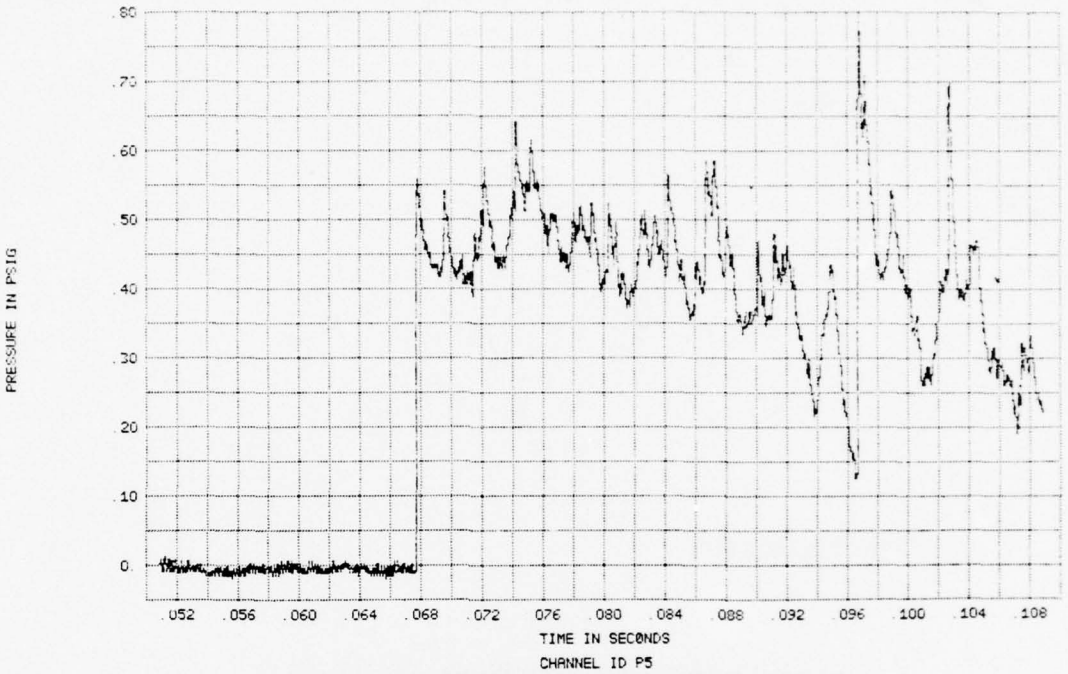


FIGURE 13-11 , SPECIMEN NO. 13 , SHOT NO. 3 , TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

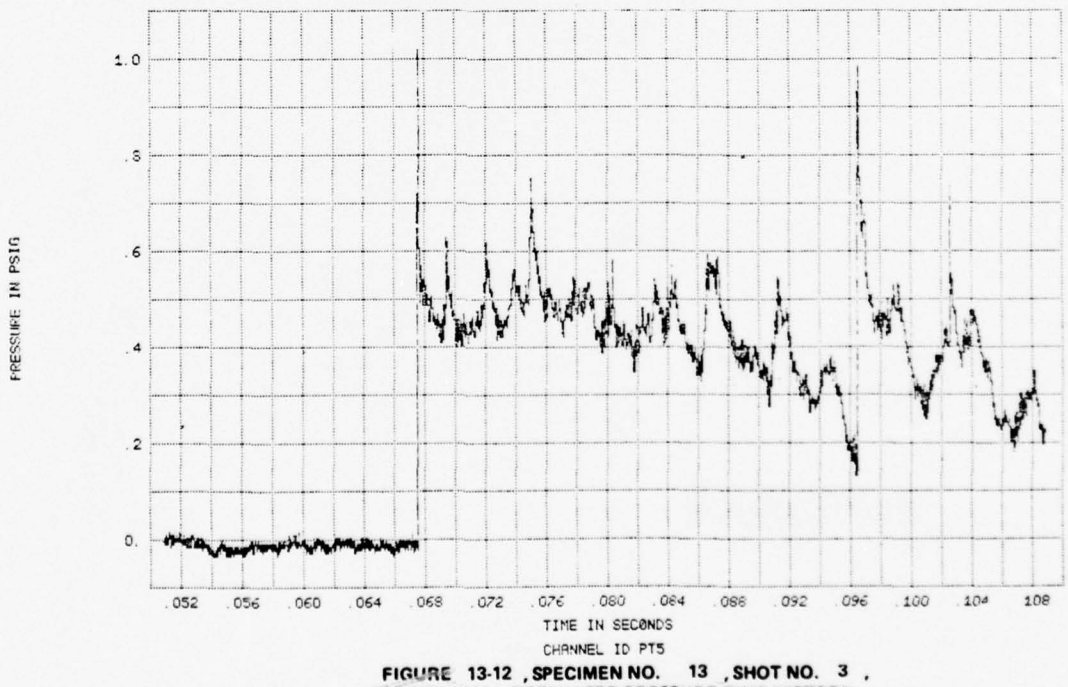


FIGURE 13-12 , SPECIMEN NO. 13 , SHOT NO. 3 , TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

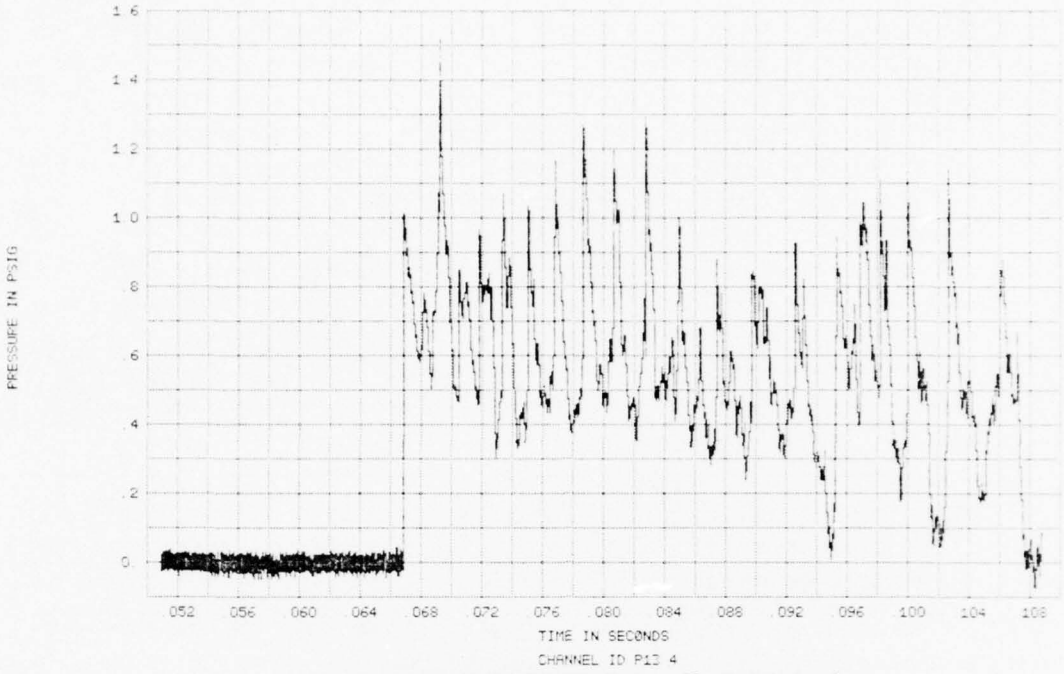


FIGURE 13-13 , SPECIMEN NO. 13 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

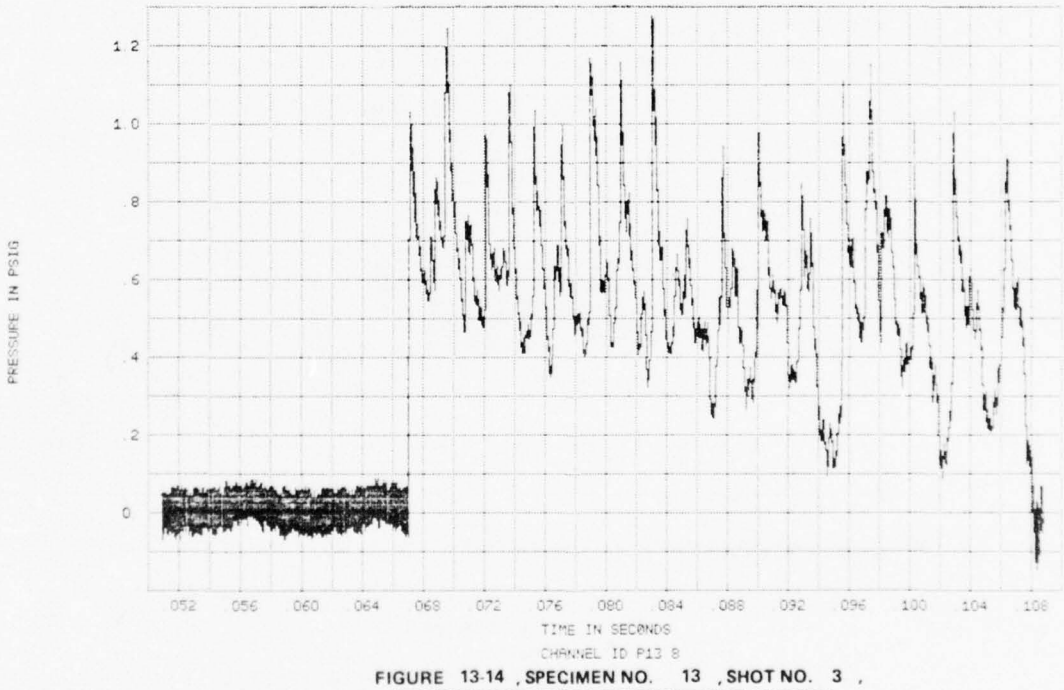


FIGURE 13-14 , SPECIMEN NO. 13 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

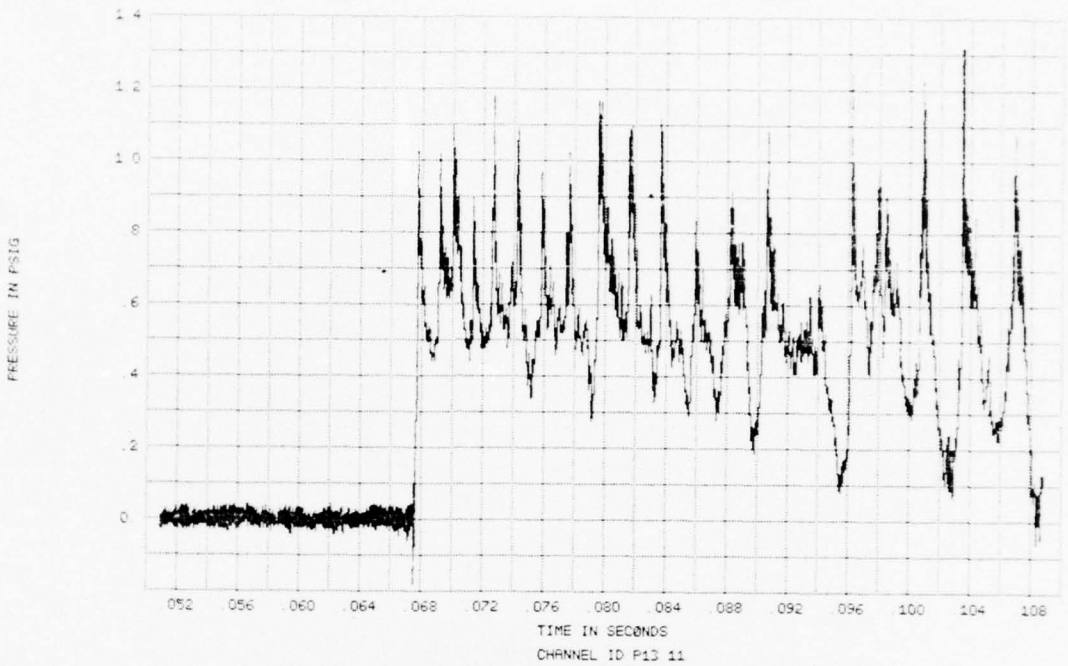


FIGURE 13-15 , SPECIMEN NO. 13 , SHOT NO. 3 , SPECIMEN REFLECTED PRESSURE TIME HISTORY

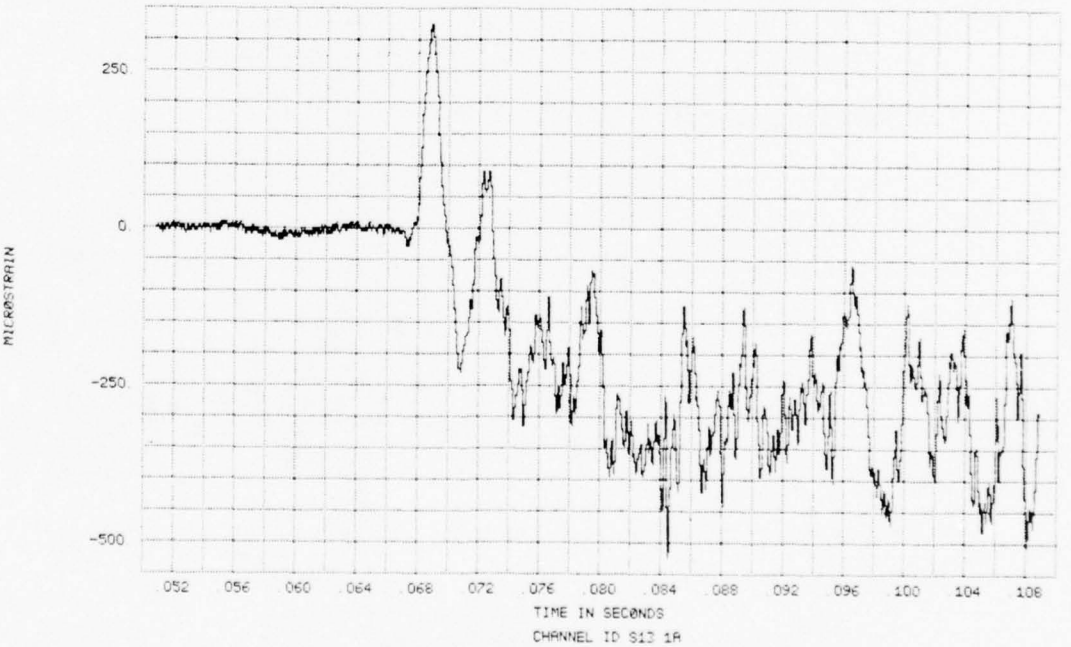


FIGURE 13-16 , SPECIMEN NO. 13 , SHOT NO. 3 , STRAIN TIME HISTORY

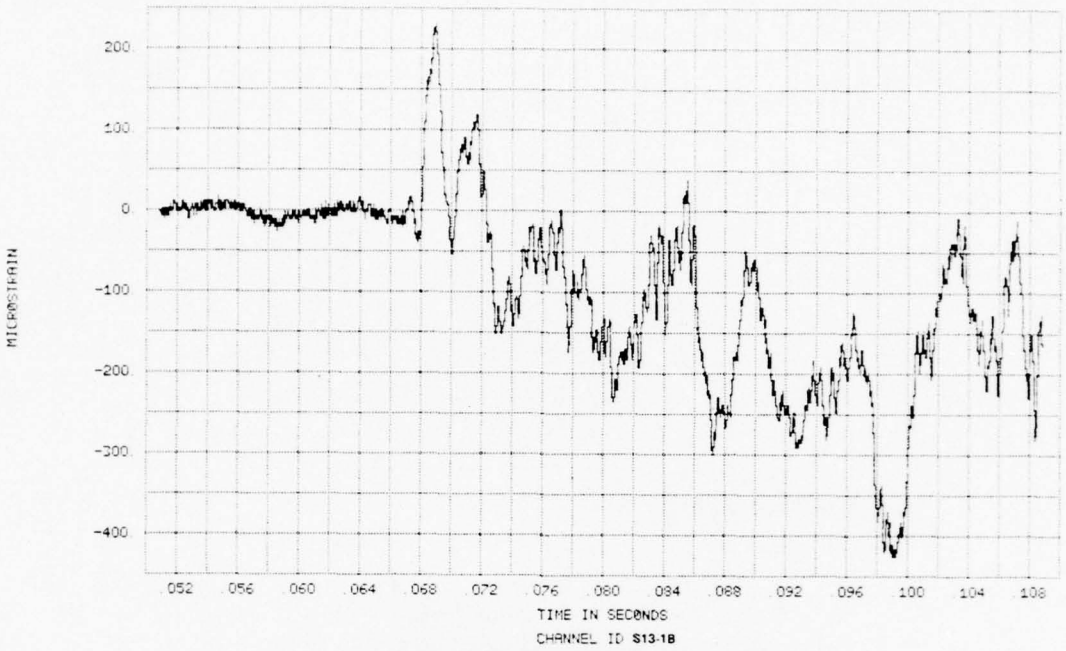


FIGURE 13-17 , SPECIMEN NO. 13 , SHOT NO. 3 , STRAIN TIME HISTORY

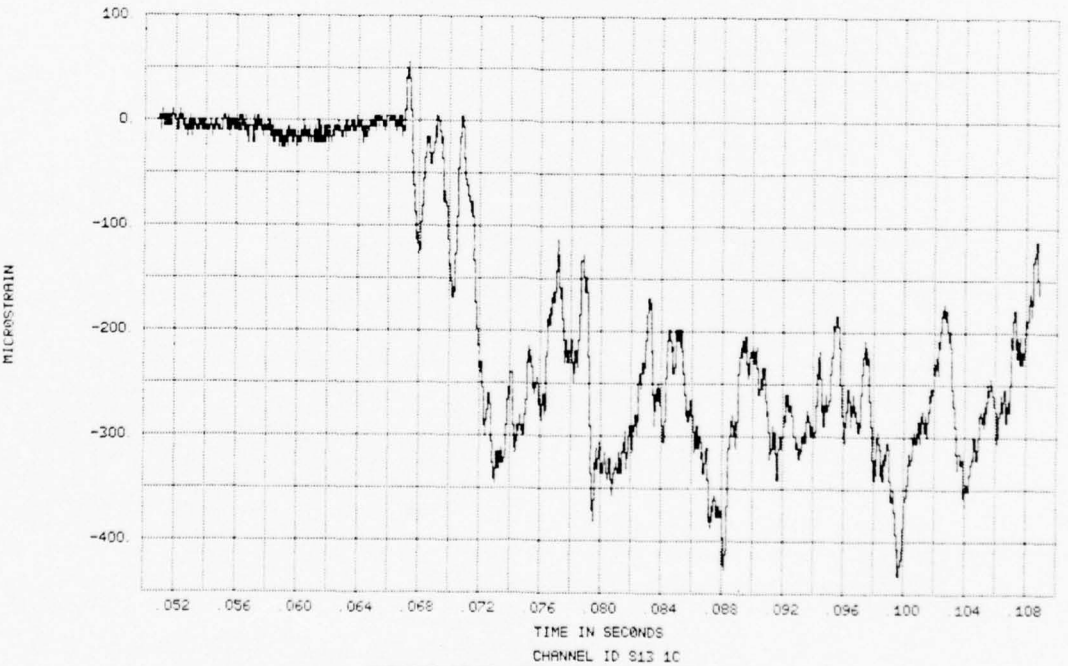


FIGURE 13-18 , SPECIMEN NO. 13 , SHOT NO. 3 , STRAIN TIME HISTORY

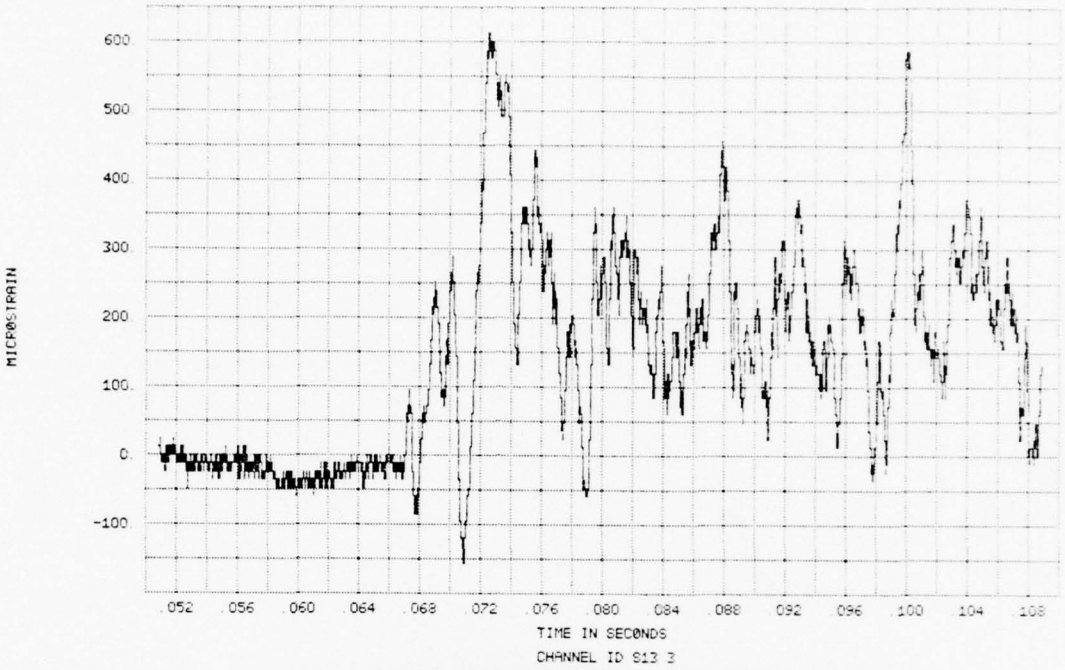


FIGURE 13-19 , SPECIMEN NO. 13 , SHOT NO. 3 , STRAIN TIME HISTORY

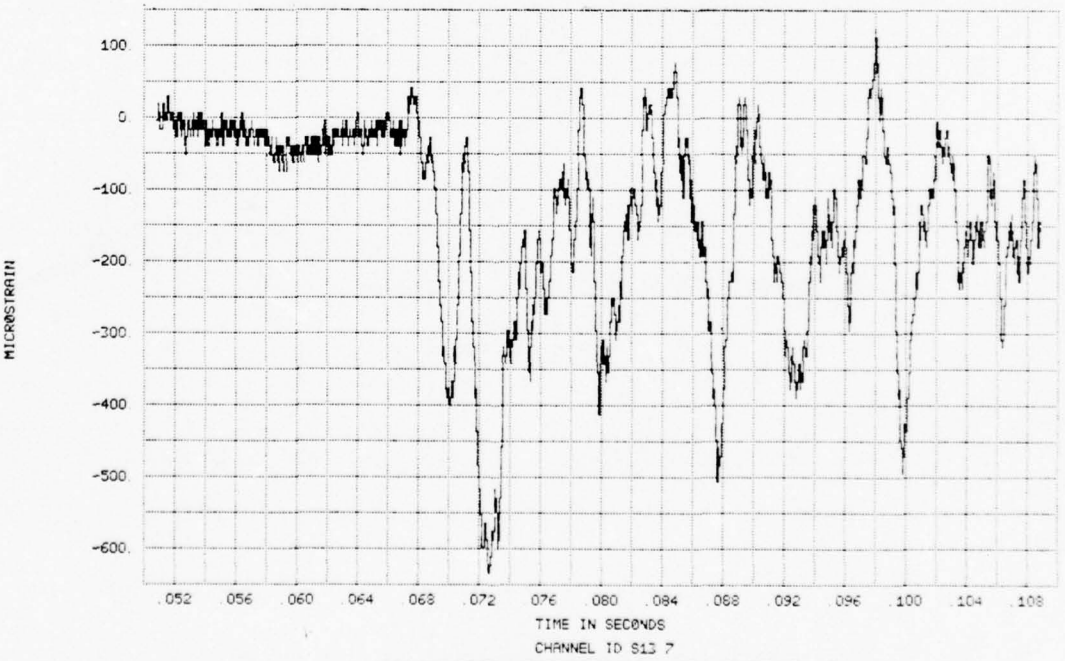


FIGURE 13-20 , SPECIMEN NO. 13 , SHOT NO. 3 , STRAIN TIME HISTORY

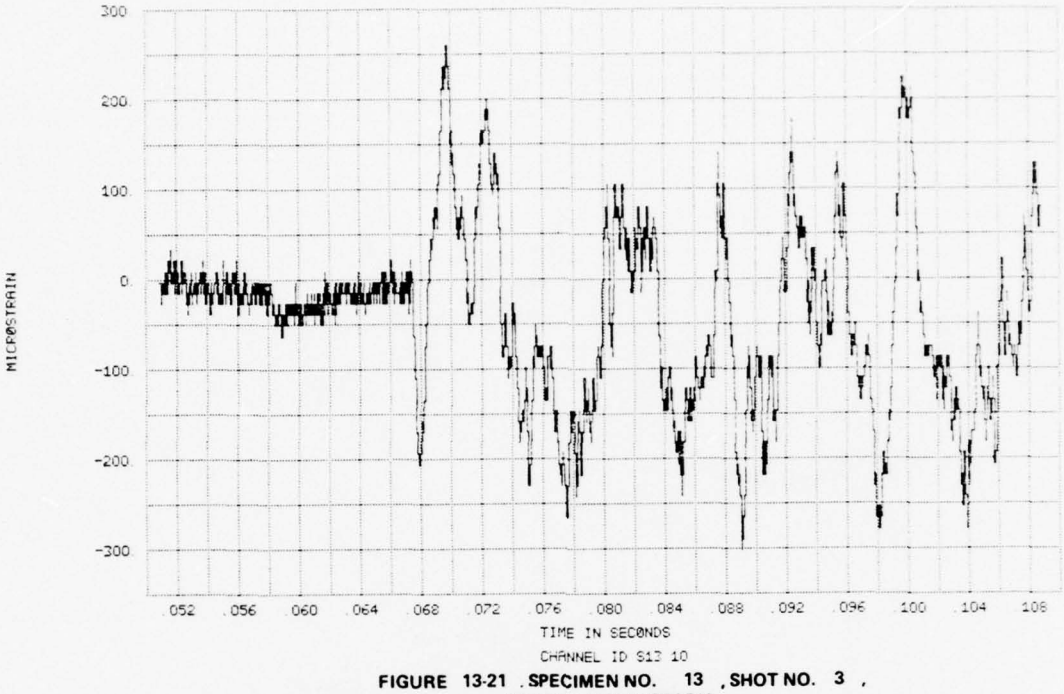


FIGURE 13-21 , SPECIMEN NO. 13 , SHOT NO. 3 , STRAIN TIME HISTORY

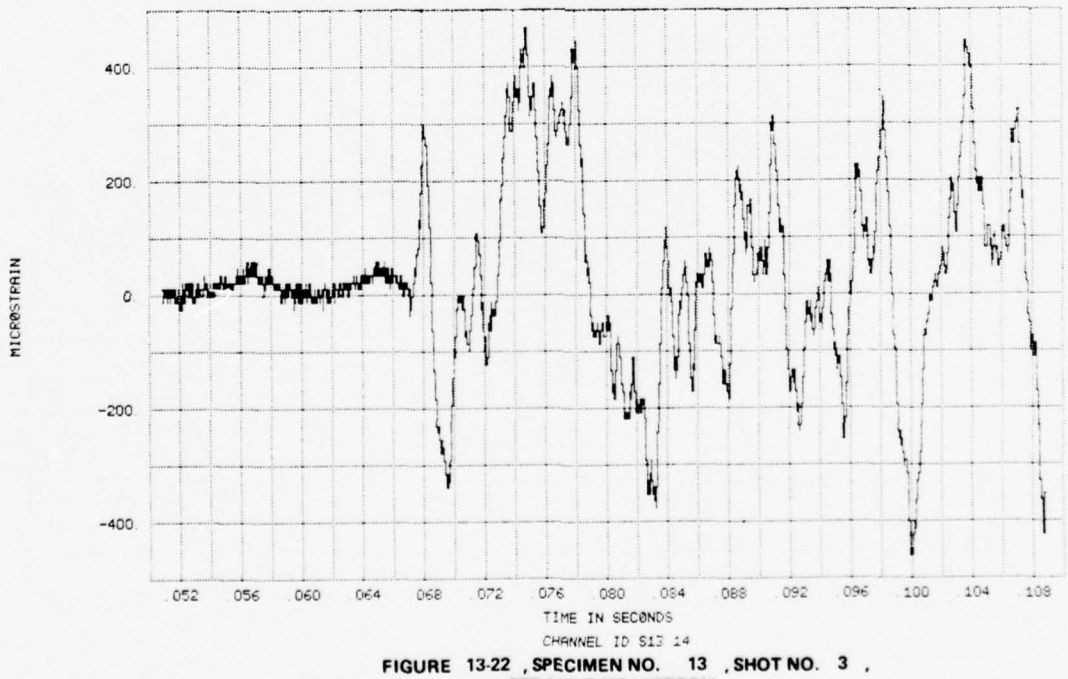


FIGURE 13-22 , SPECIMEN NO. 13 , SHOT NO. 3 , STRAIN TIME HISTORY

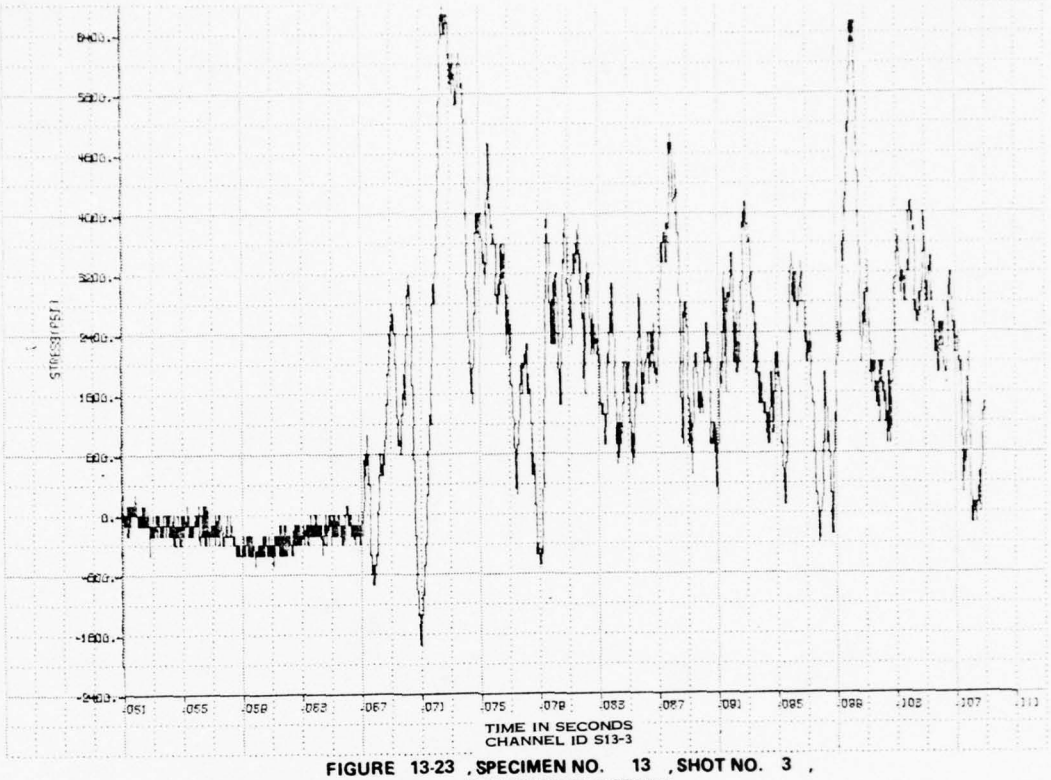


FIGURE 13-23 , SPECIMEN NO. 13 , SHOT NO. 3 ,
STRESS TIME HISTORY

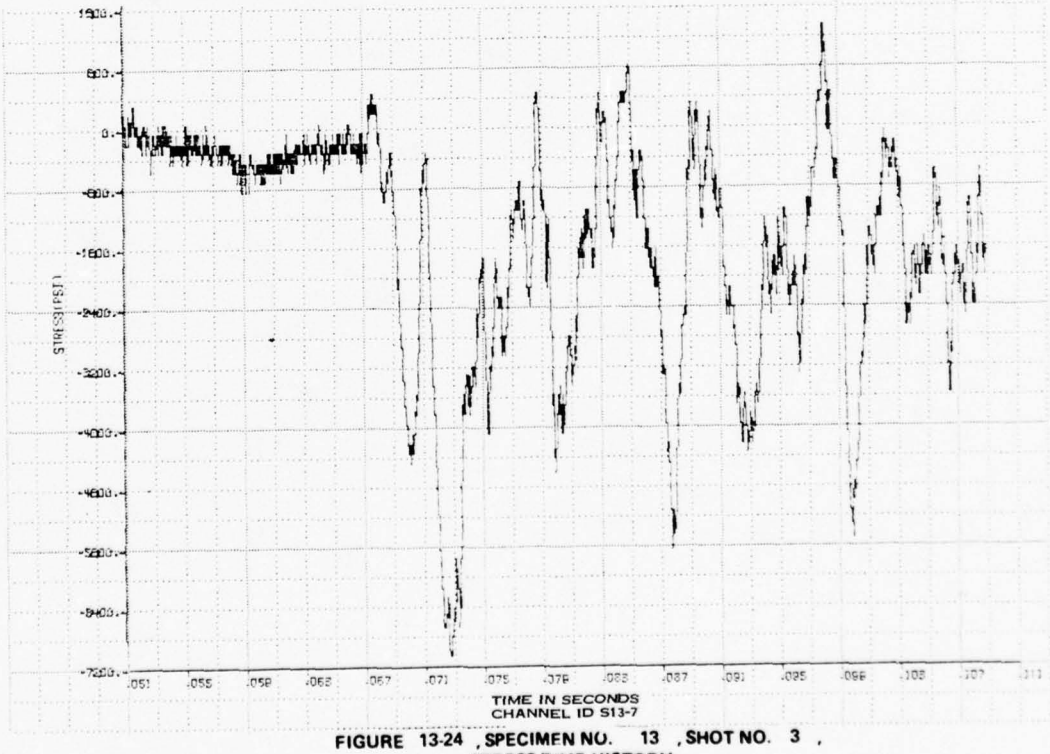


FIGURE 13-24 , SPECIMEN NO. 13 , SHOT NO. 3 ,
STRESS TIME HISTORY

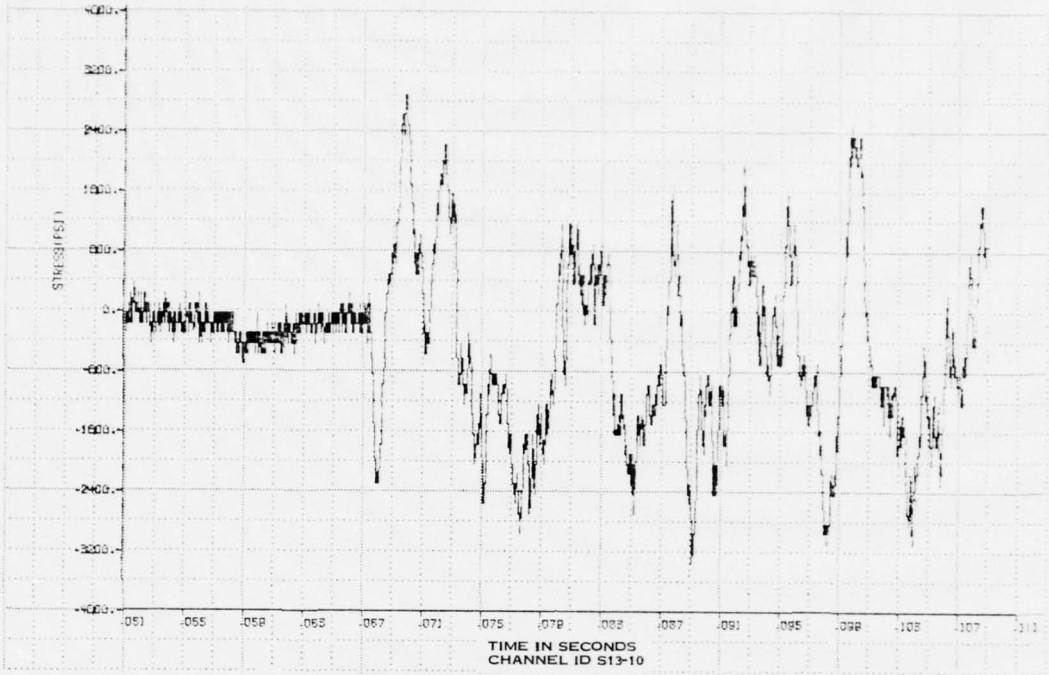


FIGURE 13-25 , SPECIMEN NO. 13 , SHOT NO. 3 ,
STRESS TIME HISTORY

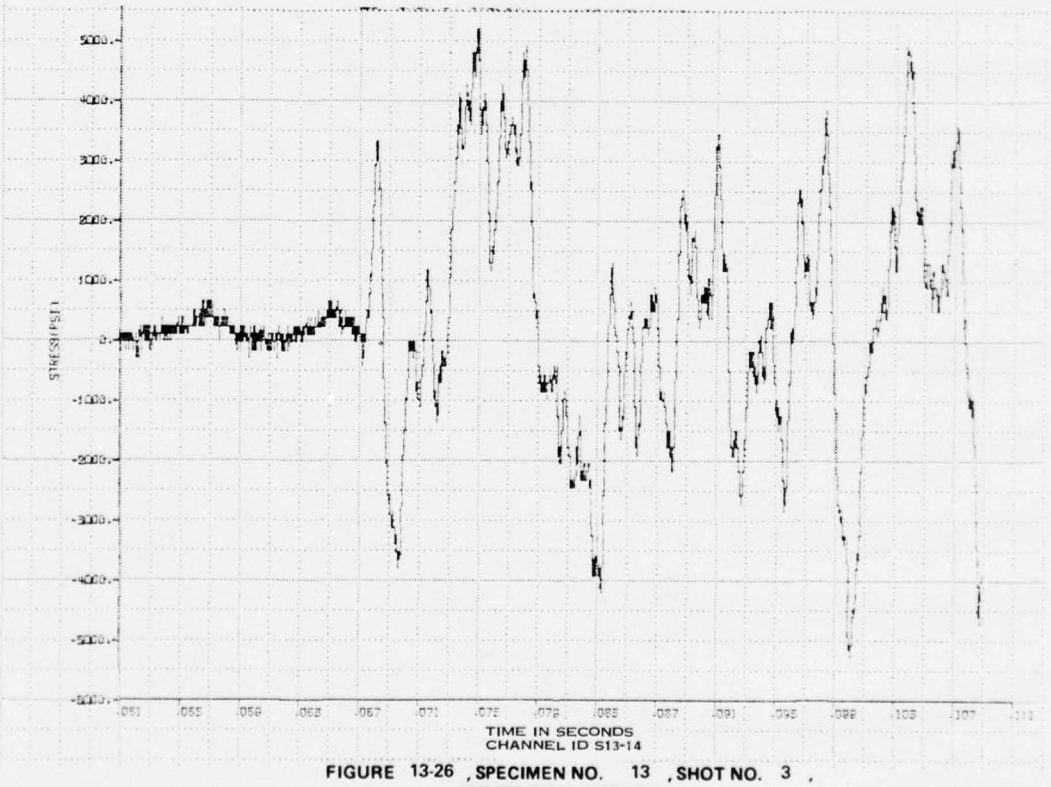


FIGURE 13-26 , SPECIMEN NO. 13 , SHOT NO. 3 ,
STRESS TIME HISTORY

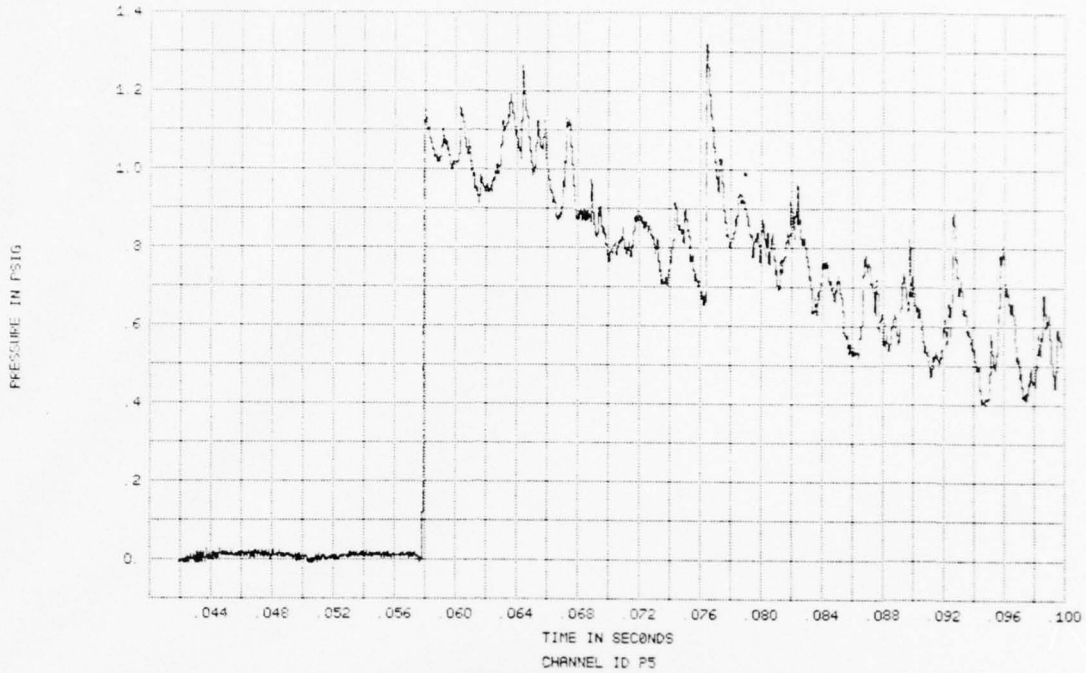


FIGURE 13-27 , SPECIMEN NO 13 , SHOT NO. 4 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

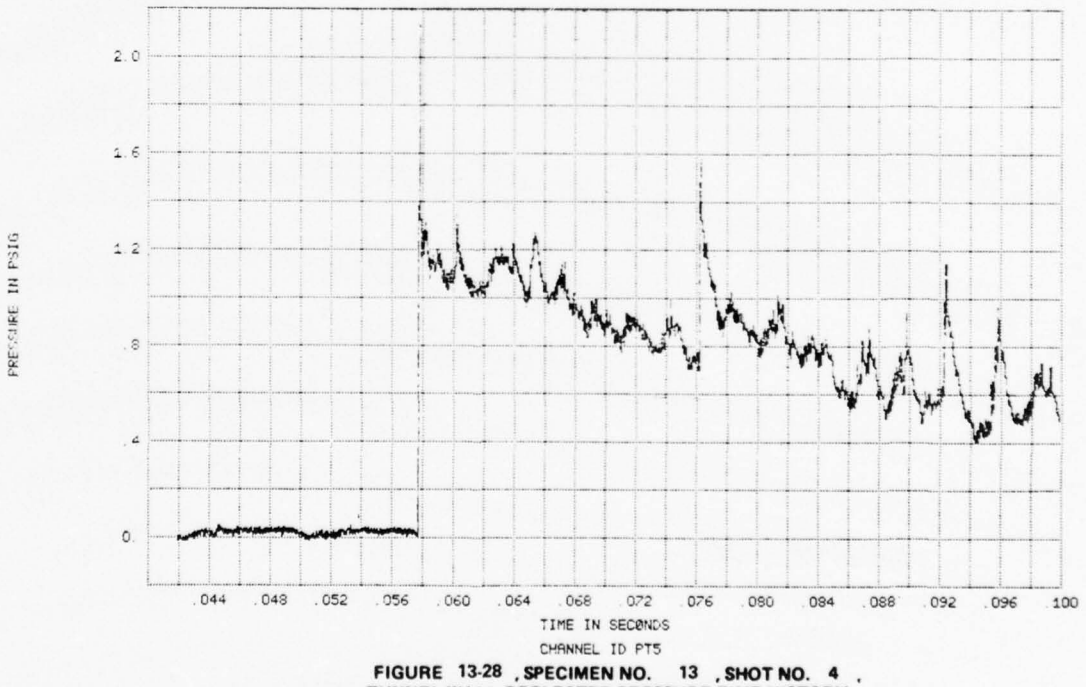


FIGURE 13-28 , SPECIMEN NO. 13 , SHOT NO. 4 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

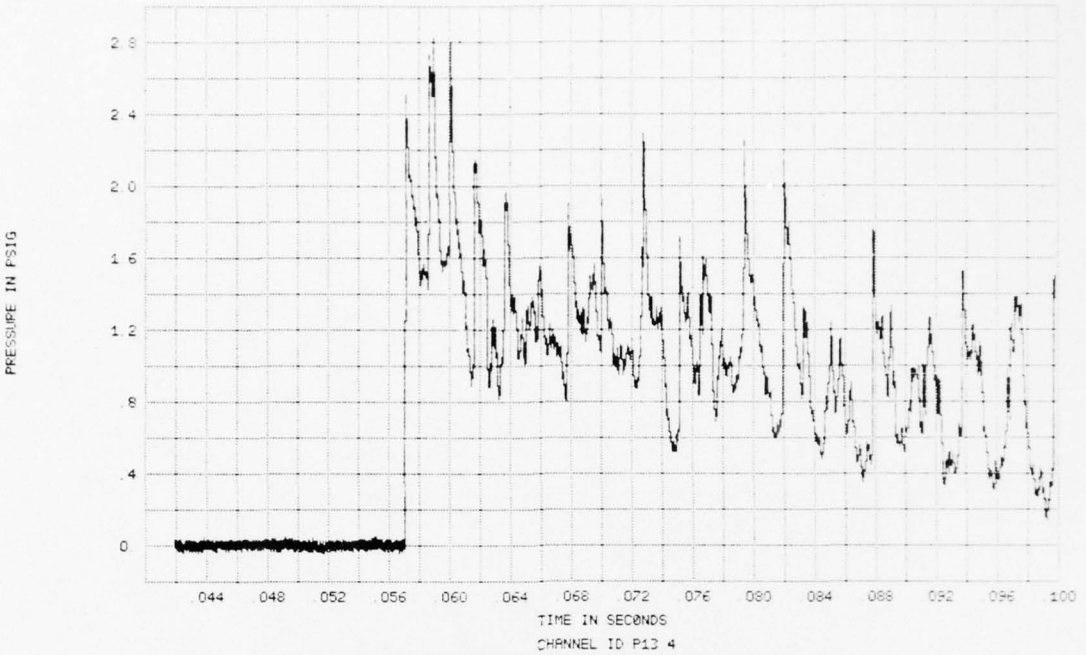


FIGURE 13-29 , SPECIMEN NO. 13 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

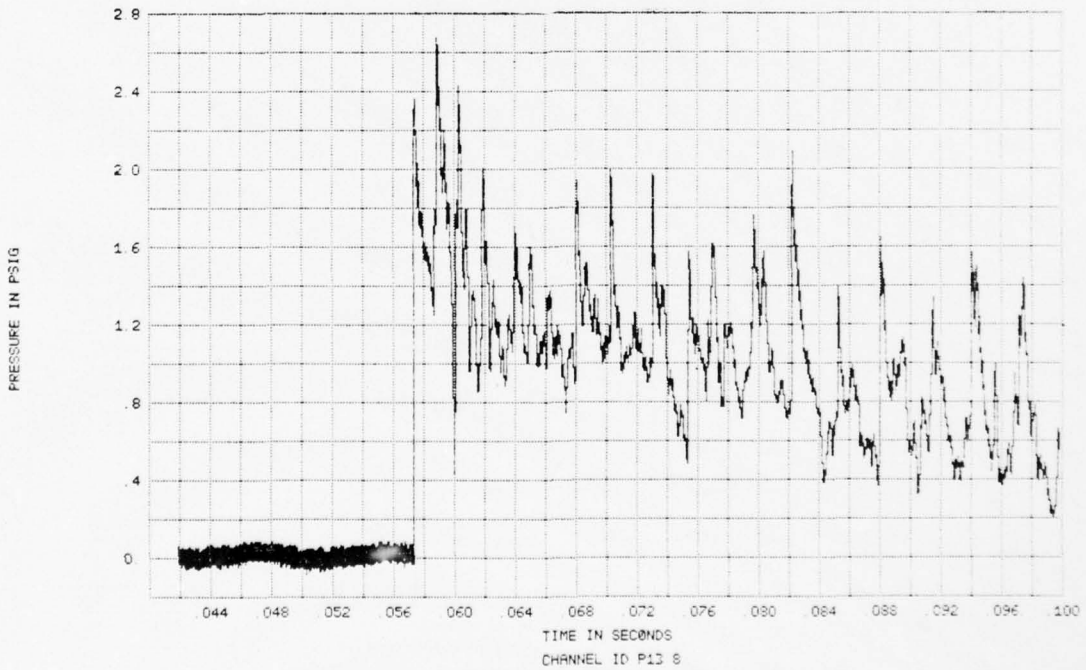


FIGURE 13-30 , SPECIMEN NO. 13 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

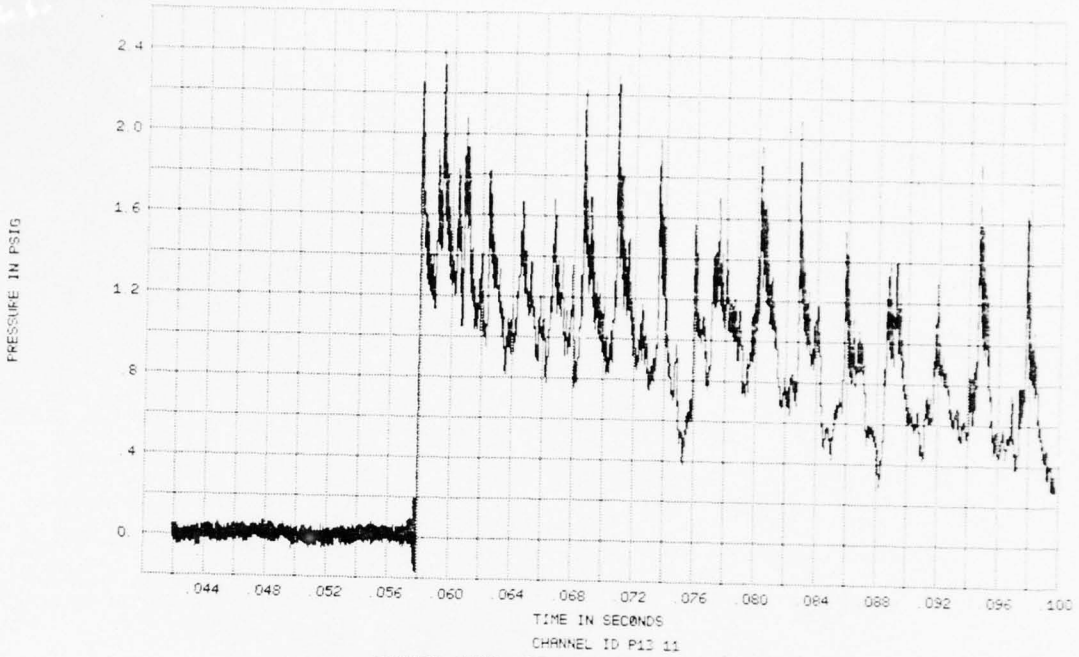


FIGURE 13-31 , SPECIMEN NO. 13 , SHOT NO. 4 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

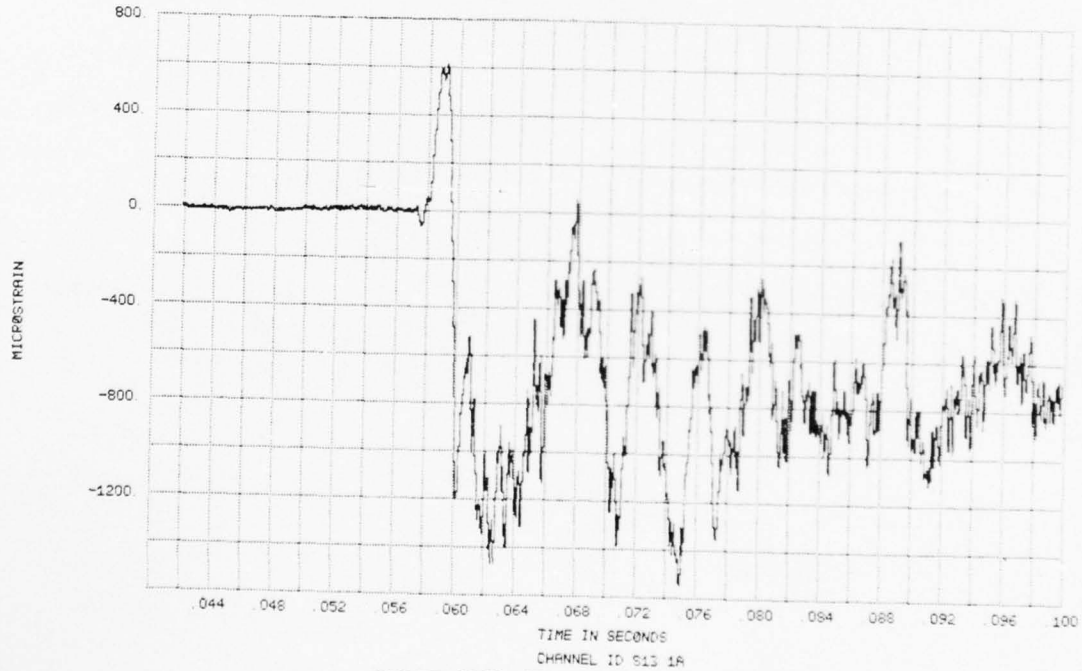


FIGURE 13-32 , SPECIMEN NO. 13 , SHOT NO. 4 ,
STRAIN TIME HISTORY

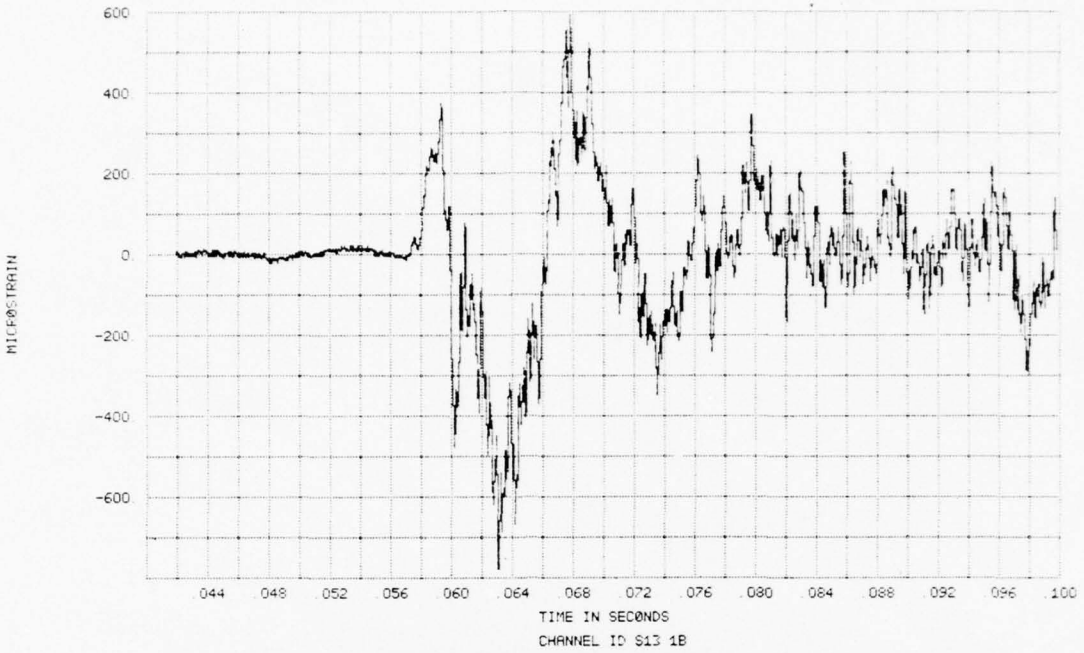


FIGURE 13-33 , SPECIMEN NO. 13 , SHOT NO. 4 , STRAIN TIME HISTORY

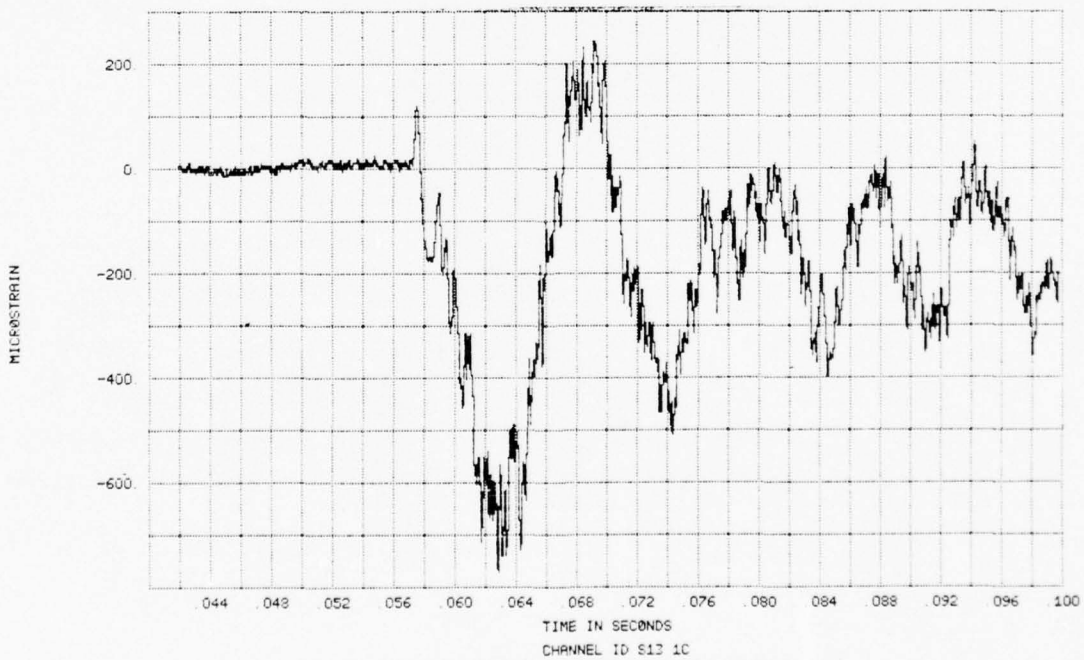


FIGURE 13-34 , SPECIMEN NO. 13 , SHOT NO. 4 , STRAIN TIME HISTORY

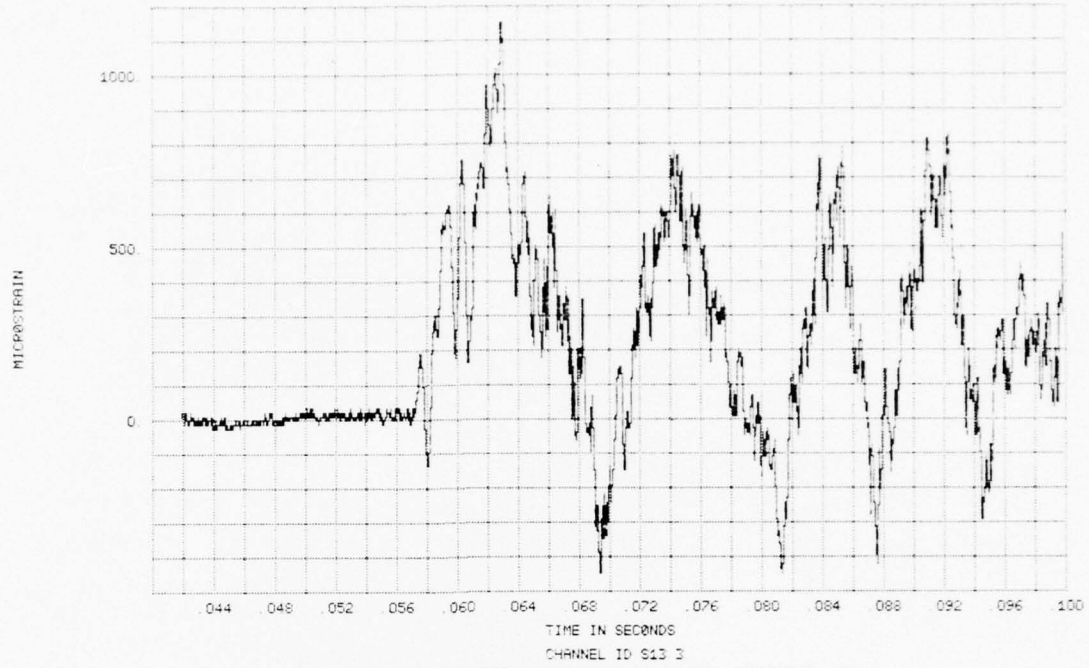


FIGURE 13-35 , SPECIMEN NO. 13 , SHOT NO. 4 , STRAIN TIME HISTORY

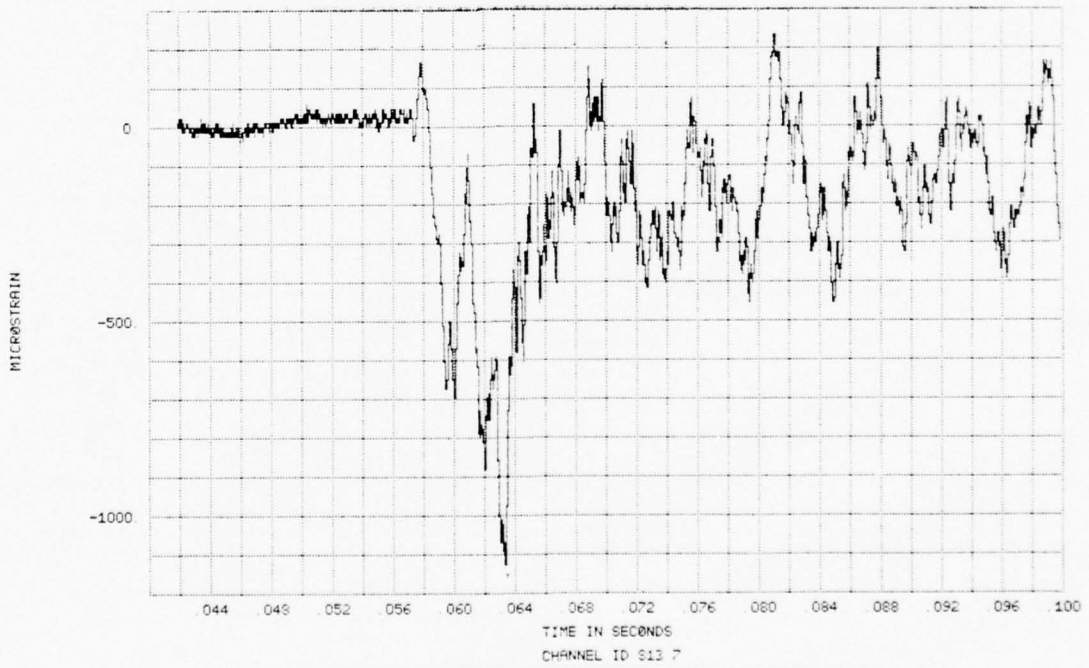


FIGURE 13-36 , SPECIMEN NO. 13 , SHOT NO. 4 , STRAIN TIME HISTORY

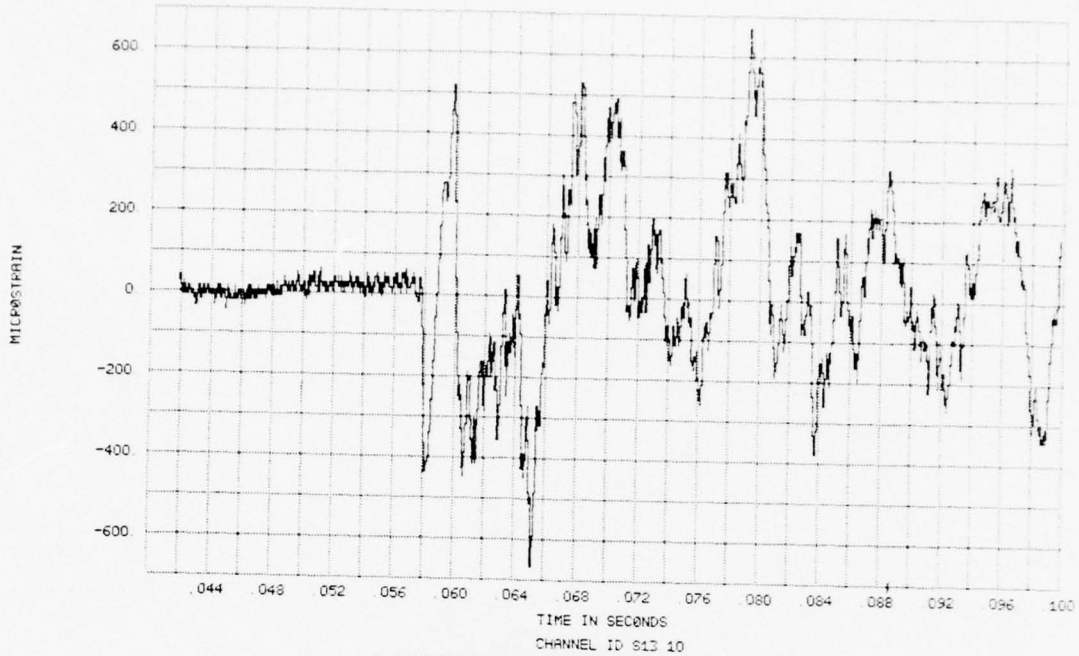


FIGURE 13-37 , SPECIMEN NO. 13 , SHOT NO. 4 ,
STRAIN TIME HISTORY

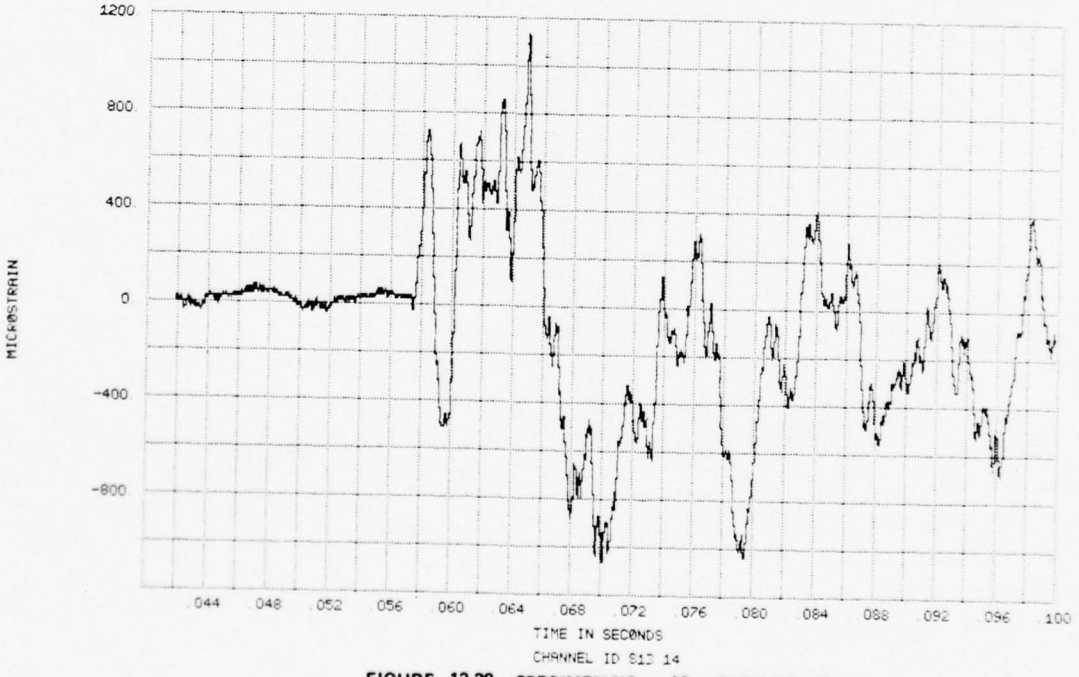


FIGURE 13-38 , SPECIMEN NO. 13 , SHOT NO. 4 ,
STRAIN TIME HISTORY

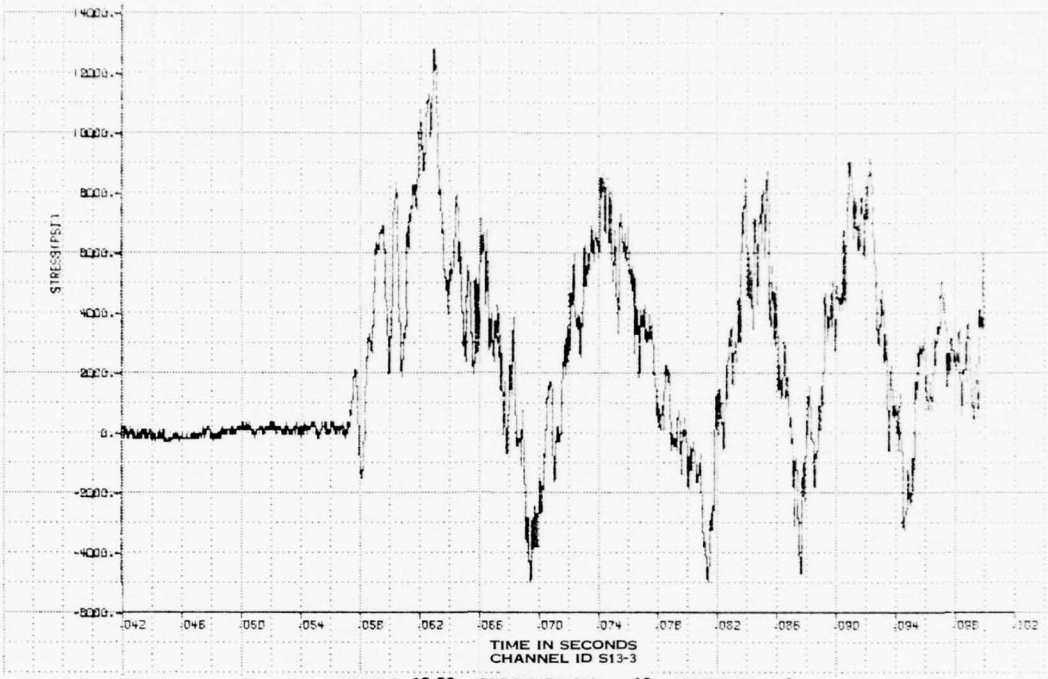


FIGURE 13-39 , SPECIMEN NO. 13 , SHOT NO. 4 ,
STRESS TIME HISTORY

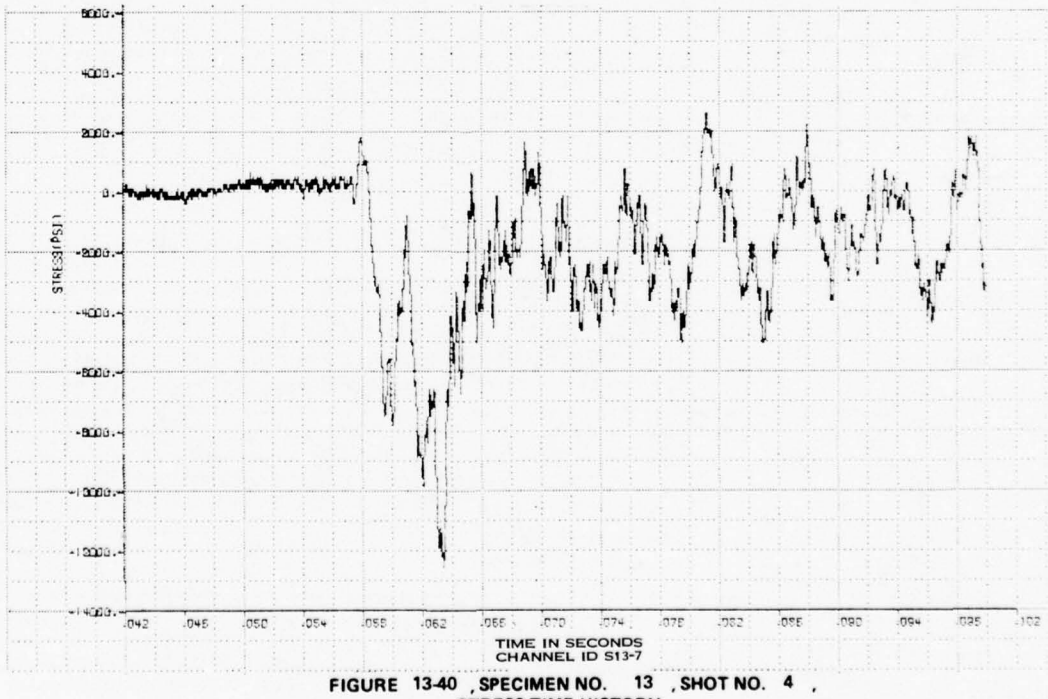


FIGURE 13-40 , SPECIMEN NO. 13 , SHOT NO. 4 ,
STRESS TIME HISTORY

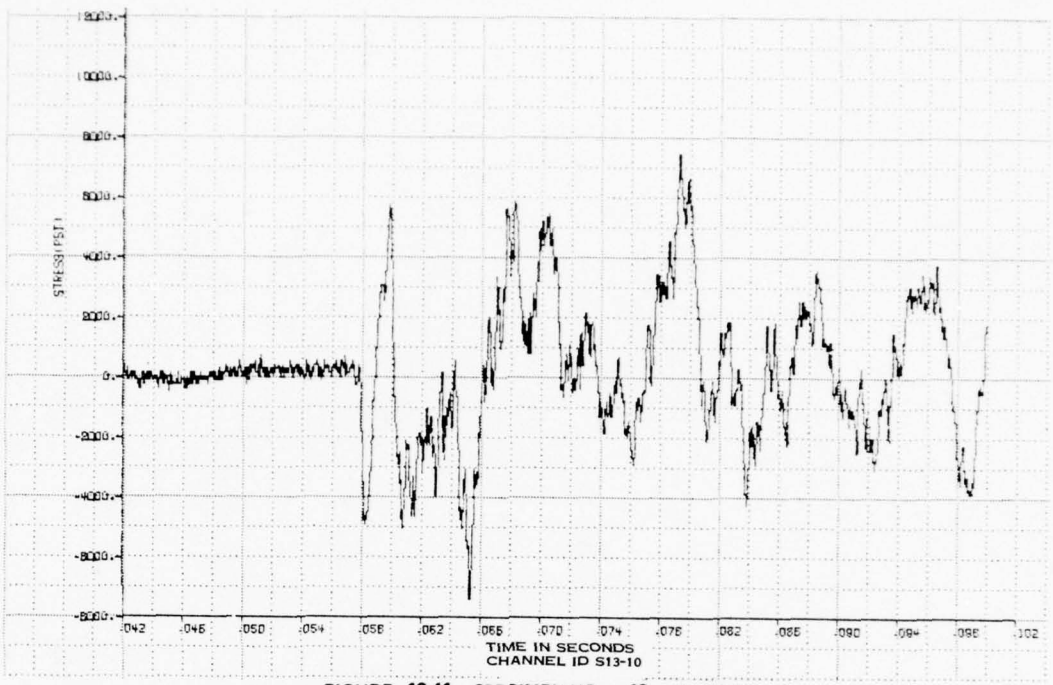


FIGURE 13-41 , SPECIMEN NO. 13 , SHOT NO. 4 ,
STRESS TIME HISTORY

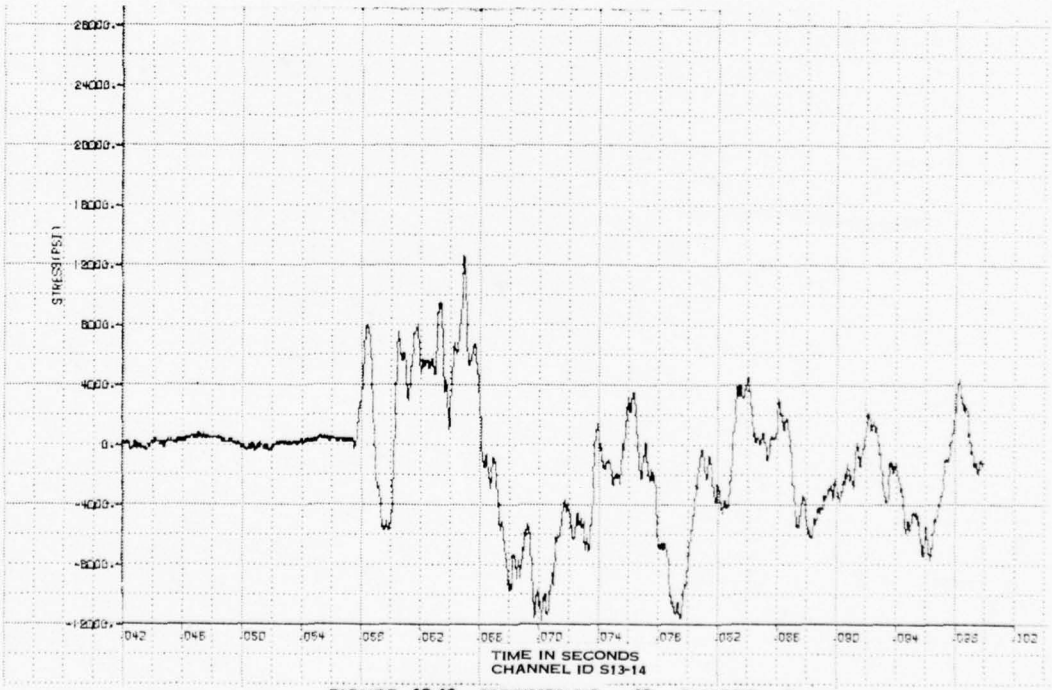


FIGURE 13-42 , SPECIMEN NO. 13 , SHOT NO. 4 ,
STRESS TIME HISTORY

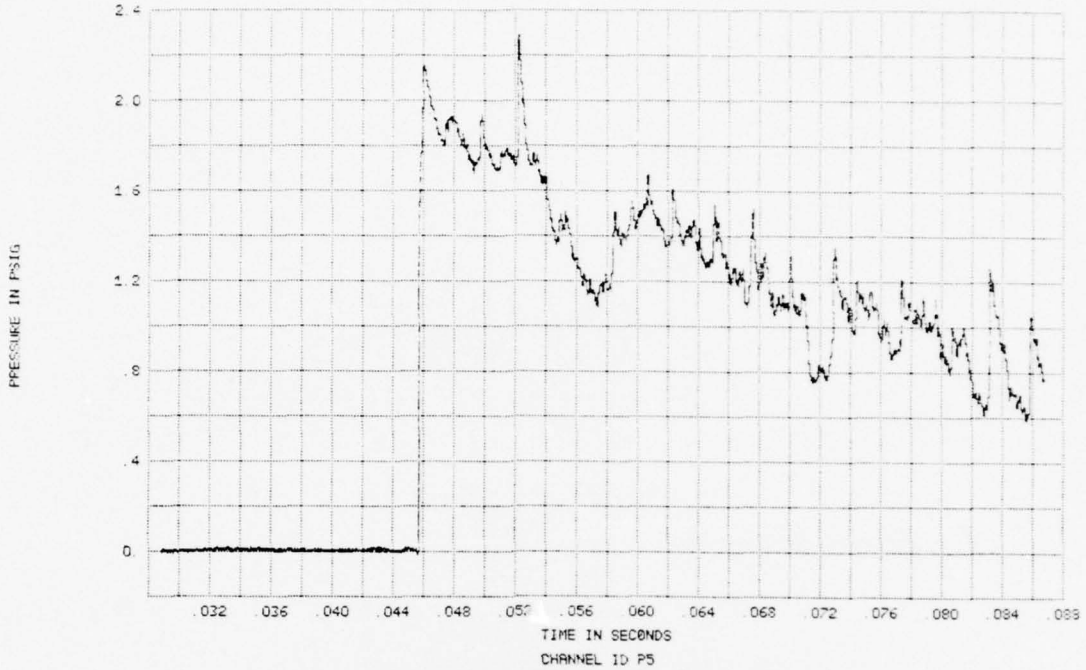


FIGURE 13-43 , SPECIMEN NO. 13 , SHOT NO. 5 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

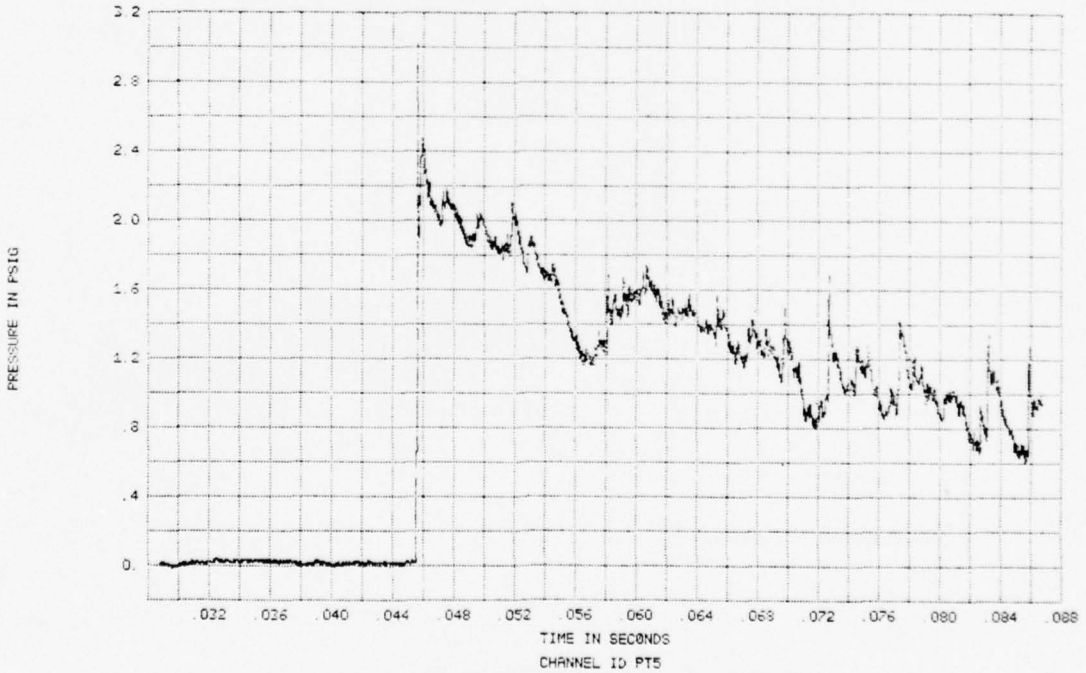


FIGURE 13-44 , SPECIMEN NO. 13 , SHOT NO. 5 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

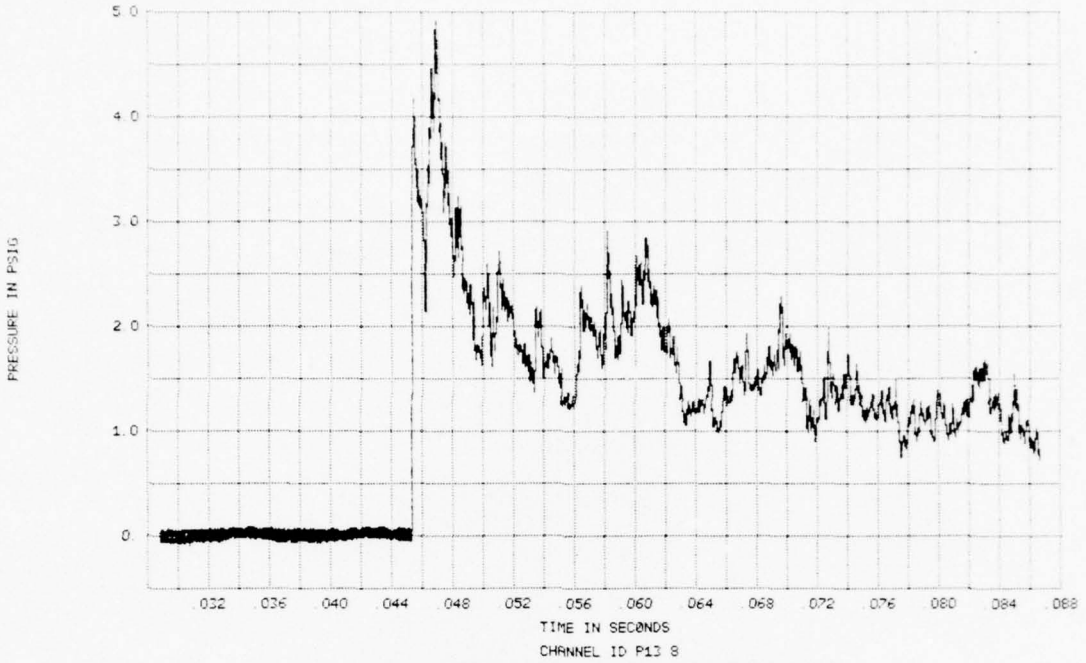


FIGURE 13-45 , SPECIMEN NO. 13 , SHOT NO. 5 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

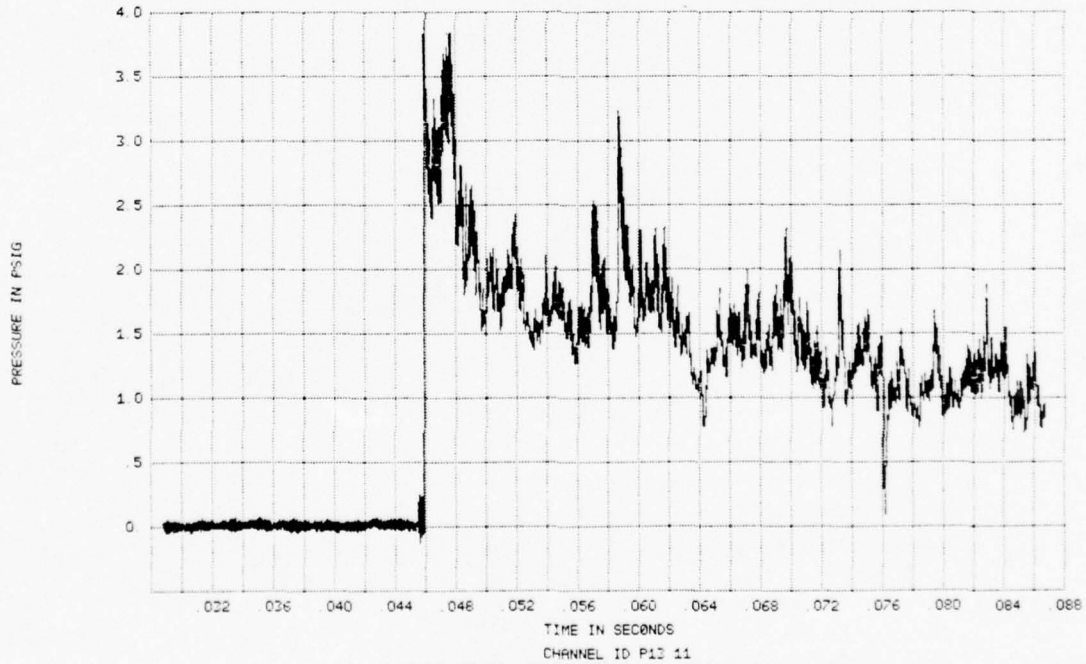


FIGURE 13-46 , SPECIMEN NO. 13 , SHOT NO. 5 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

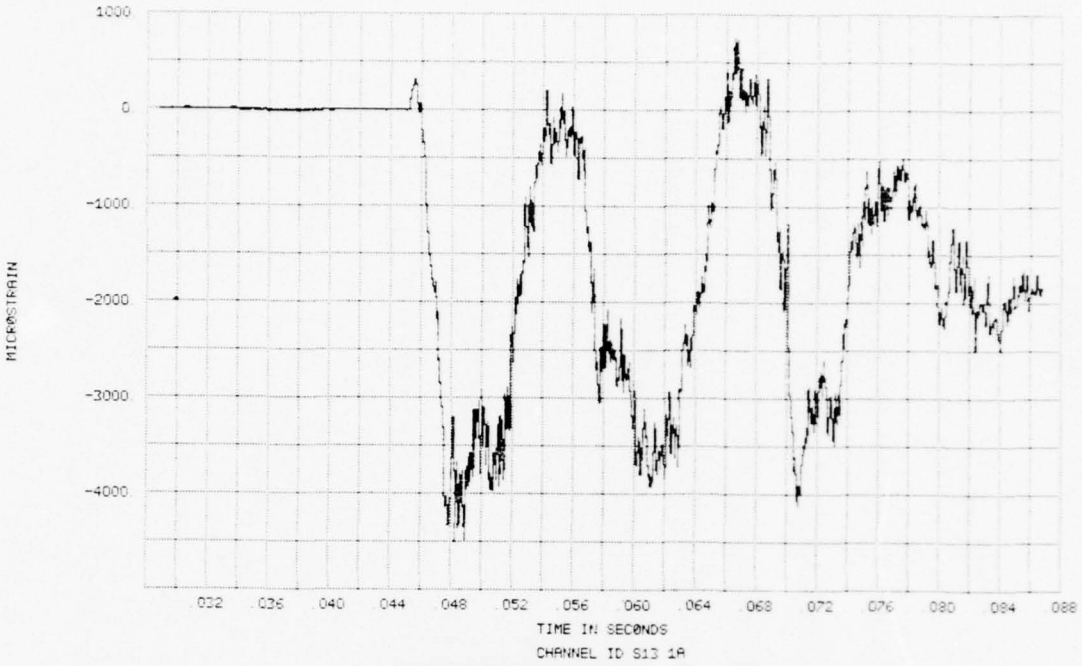


FIGURE 13-47 , SPECIMEN NO. 13 , SHOT NO. 5 ,
STRAIN TIME HISTORY

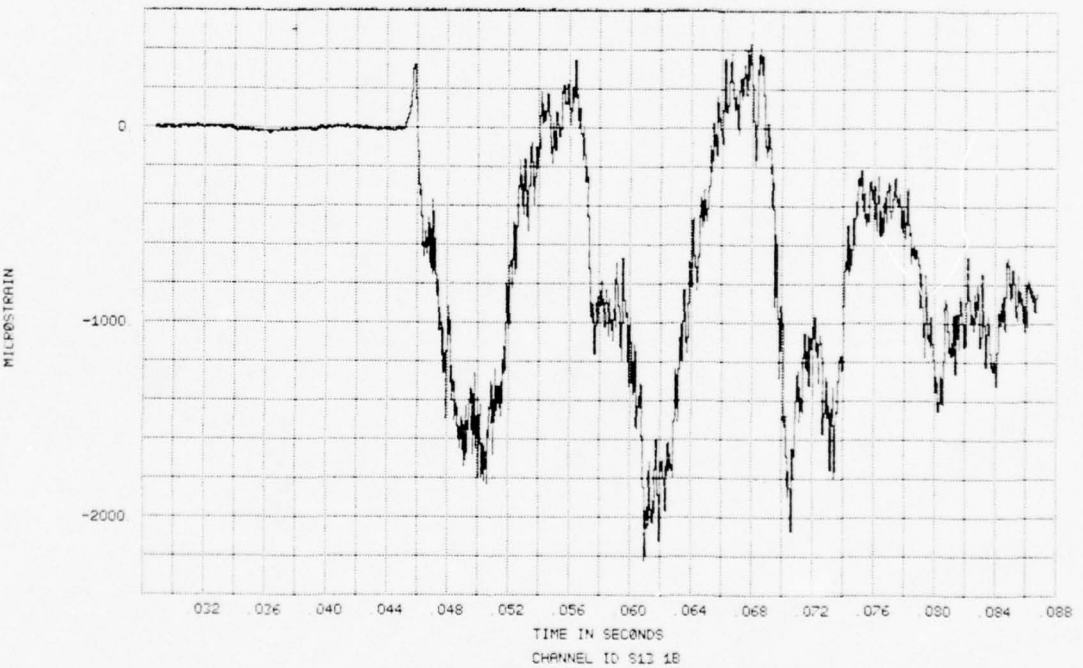


FIGURE 13-48 , SPECIMEN NO. 13 , SHOT NO. 5 ,
STRAIN TIME HISTORY

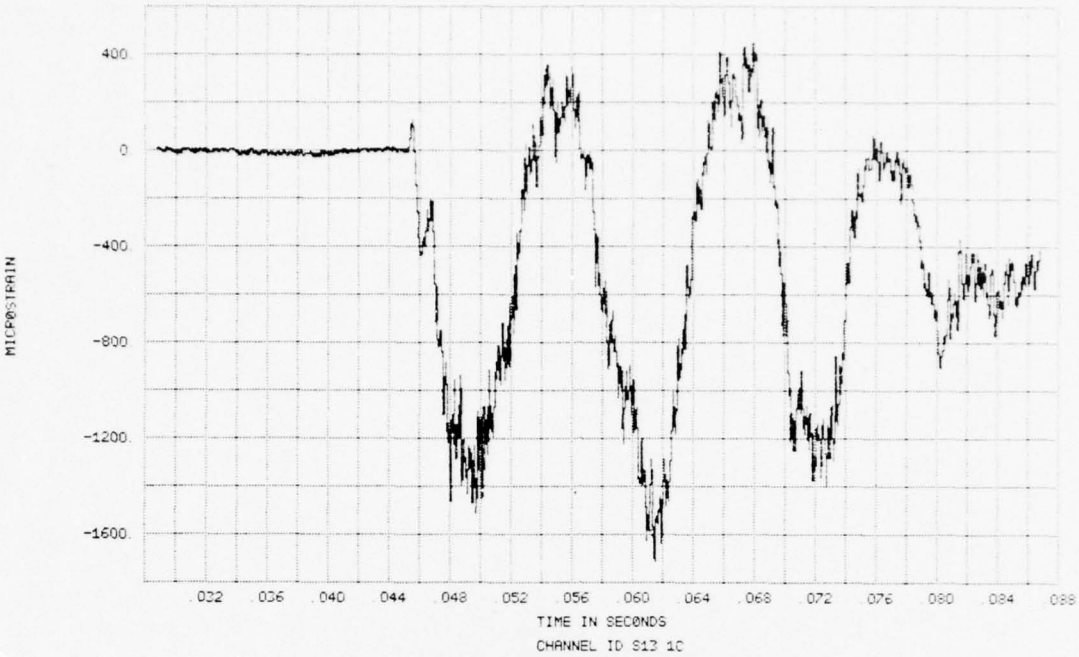


FIGURE 13-49 , SPECIMEN NO. 13 , SHOT NO. 5 , STRAIN TIME HISTORY

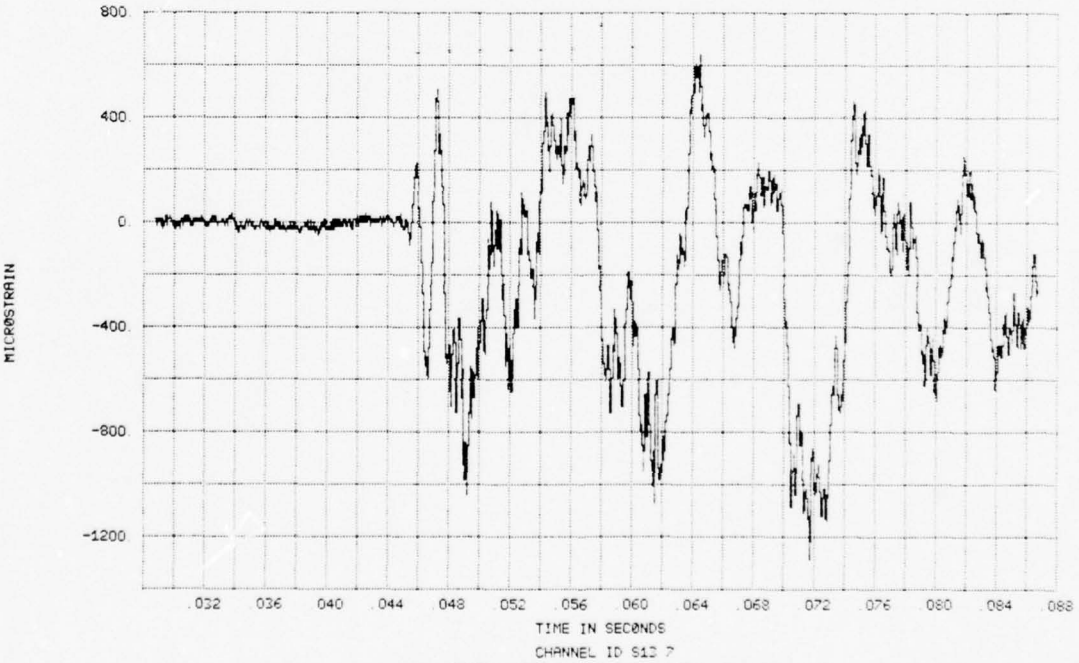


FIGURE 13-50 , SPECIMEN NO. 13 , SHOT NO. 5 , STRAIN TIME HISTORY

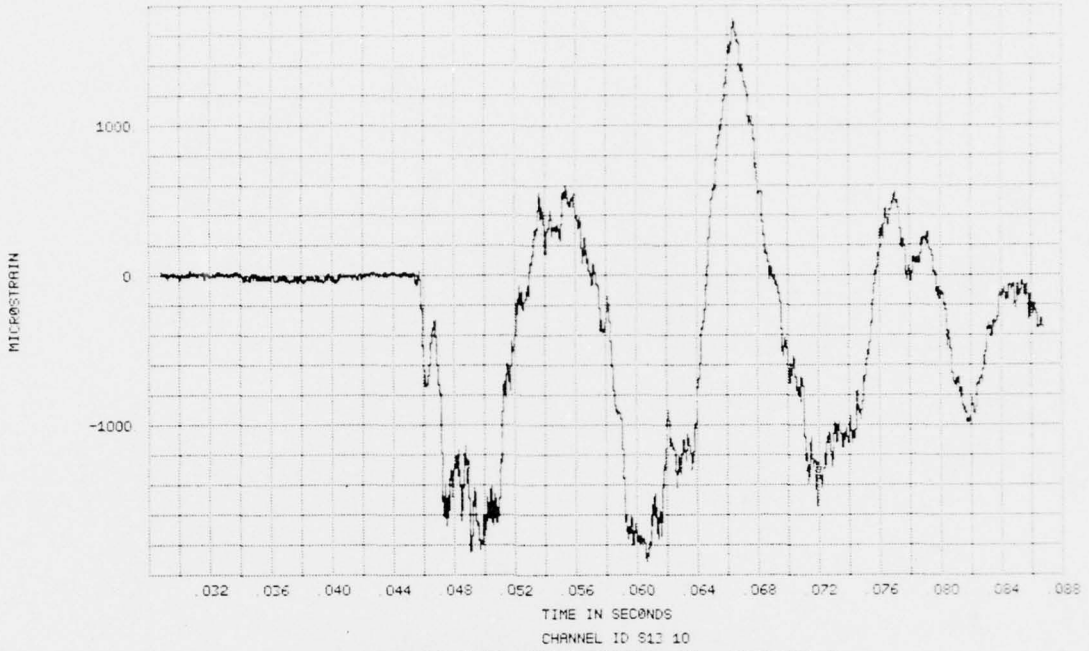


FIGURE 13-51 , SPECIMEN NO. 13 , SHOT NO. 5 , STRAIN TIME HISTORY

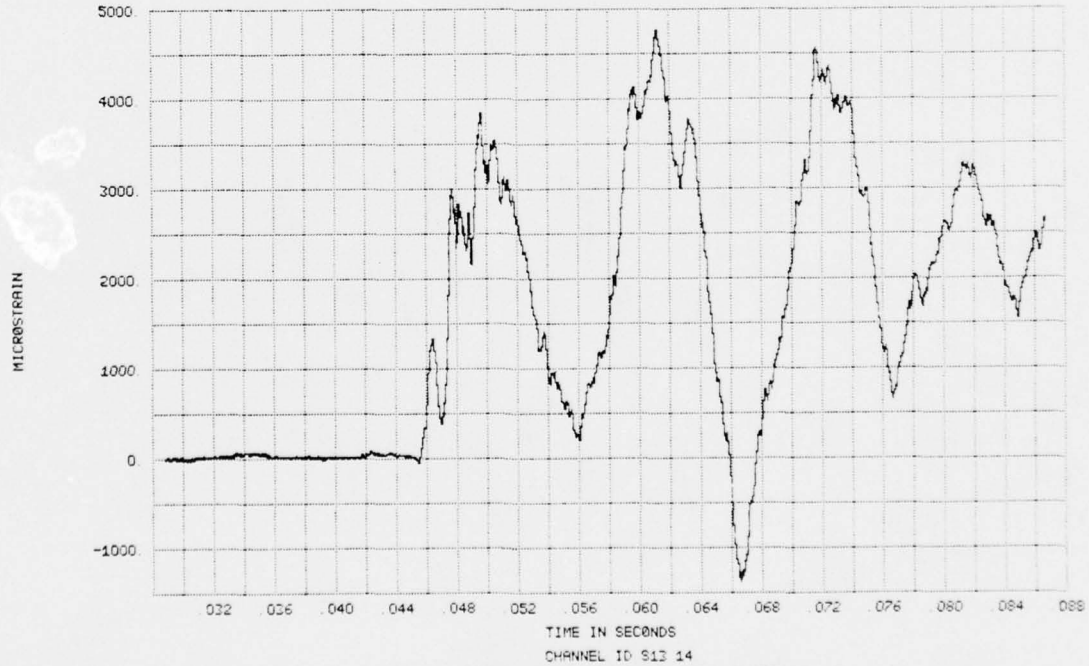


FIGURE 13-52 , SPECIMEN NO. 13 , SHOT NO. 5 , STRAIN TIME HISTORY

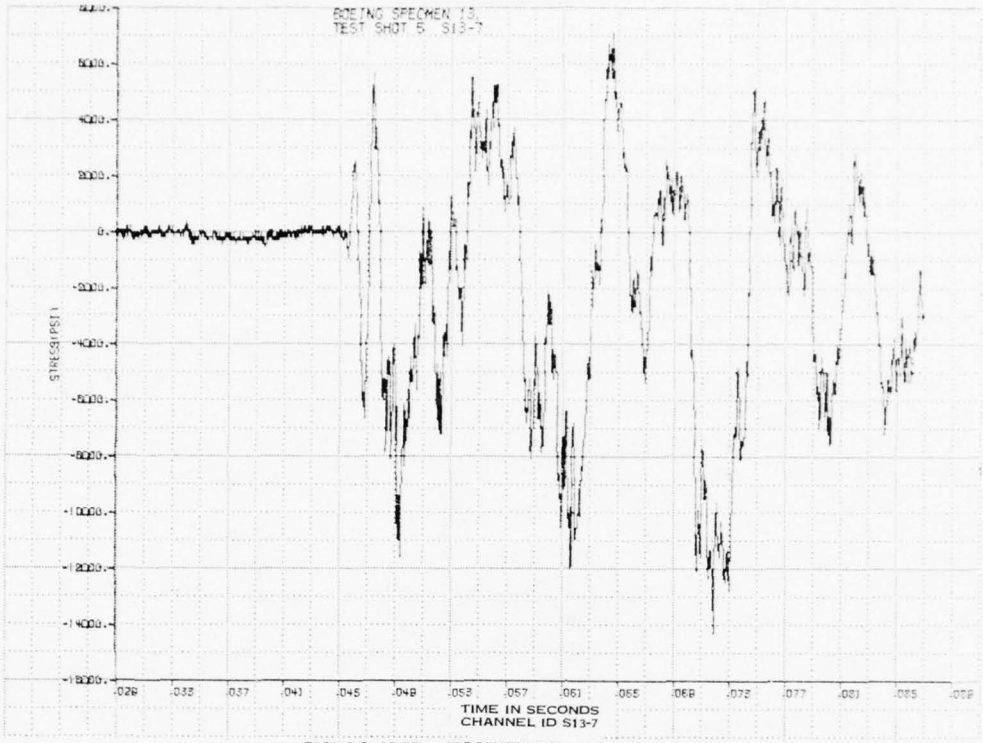


FIGURE 13-53 , SPECIMEN NO. 13 , SHOT NO. 5 ,
STRESS TIME HISTORY

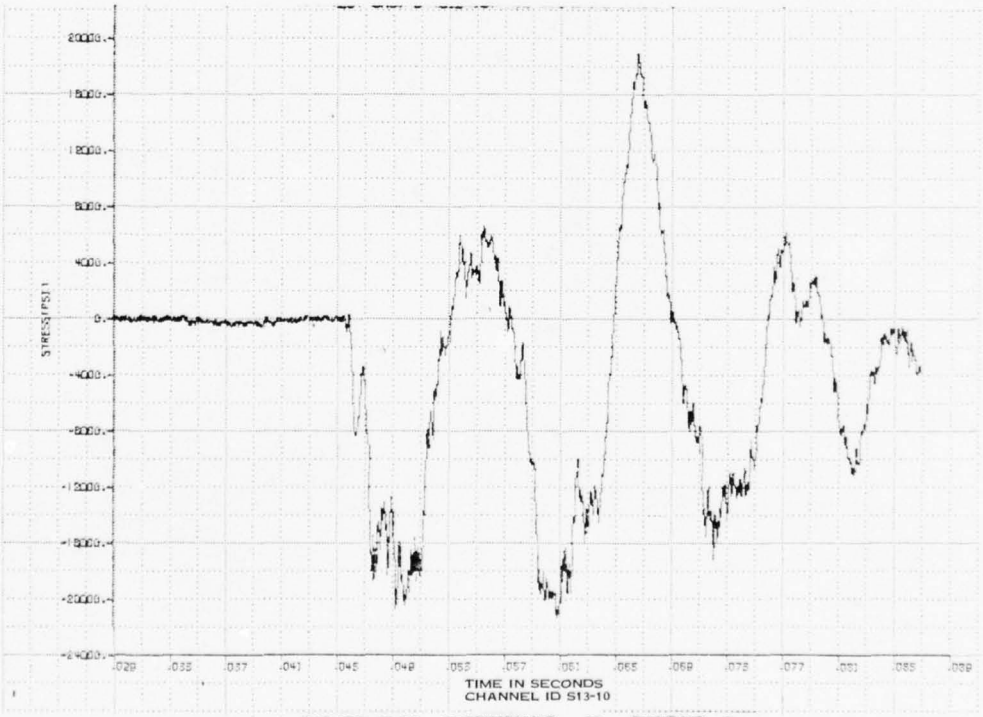


FIGURE 13-54 , SPECIMEN NO. 13 , SHOT NO. 5 ,
STRESS TIME HISTORY

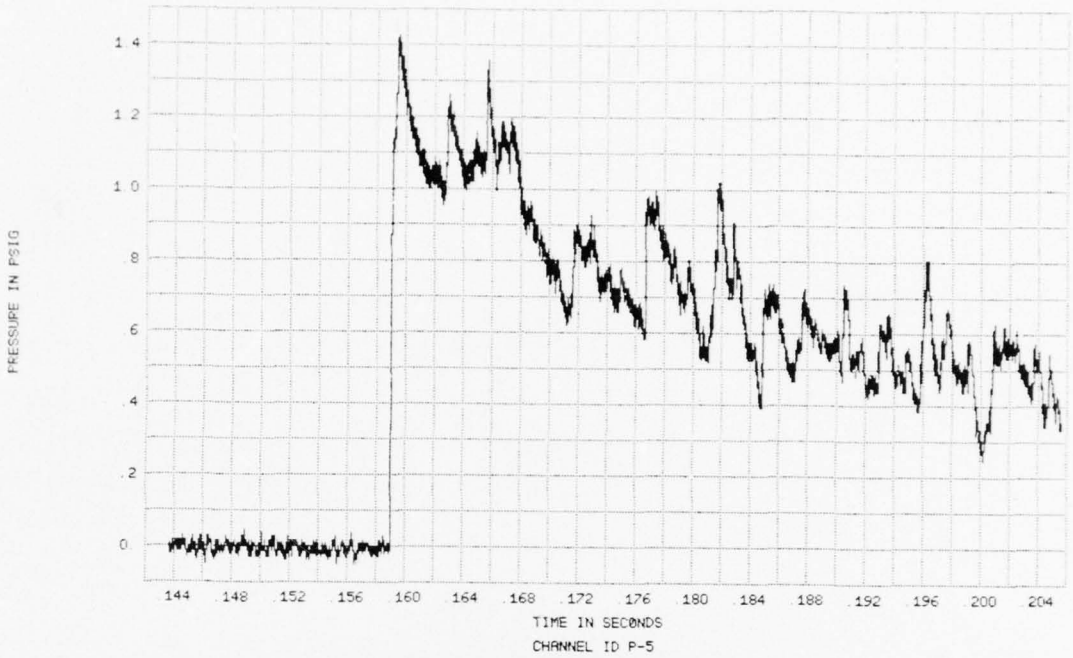


FIGURE 13-55 , SPECIMEN NO. 13 , SHOT NO. 6 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

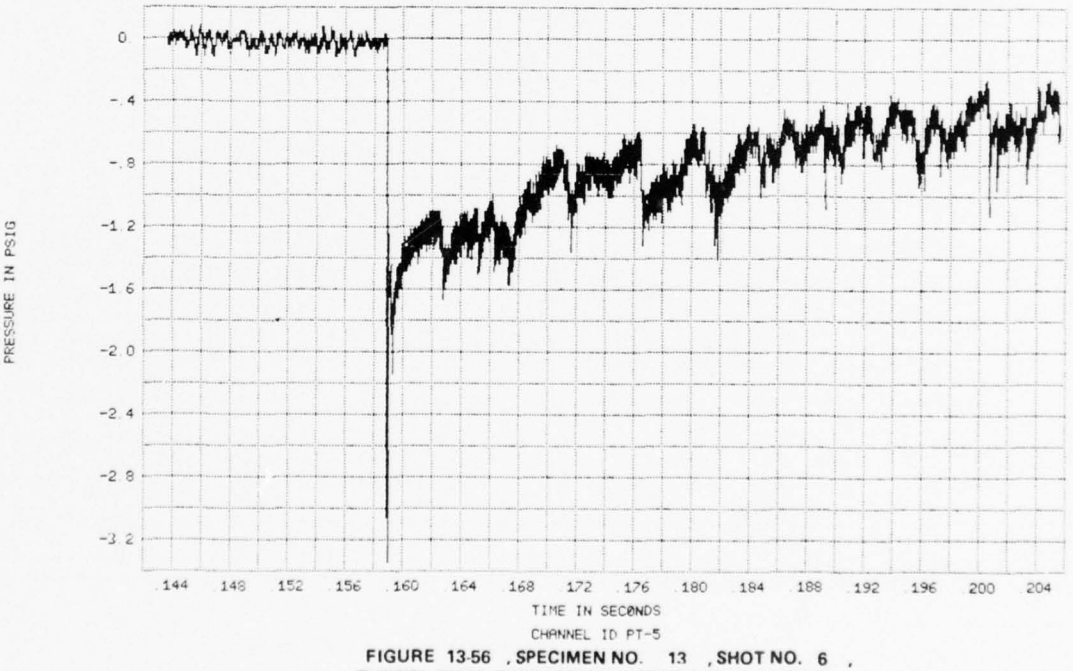


FIGURE 13-56 , SPECIMEN NO. 13 , SHOT NO. 6 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

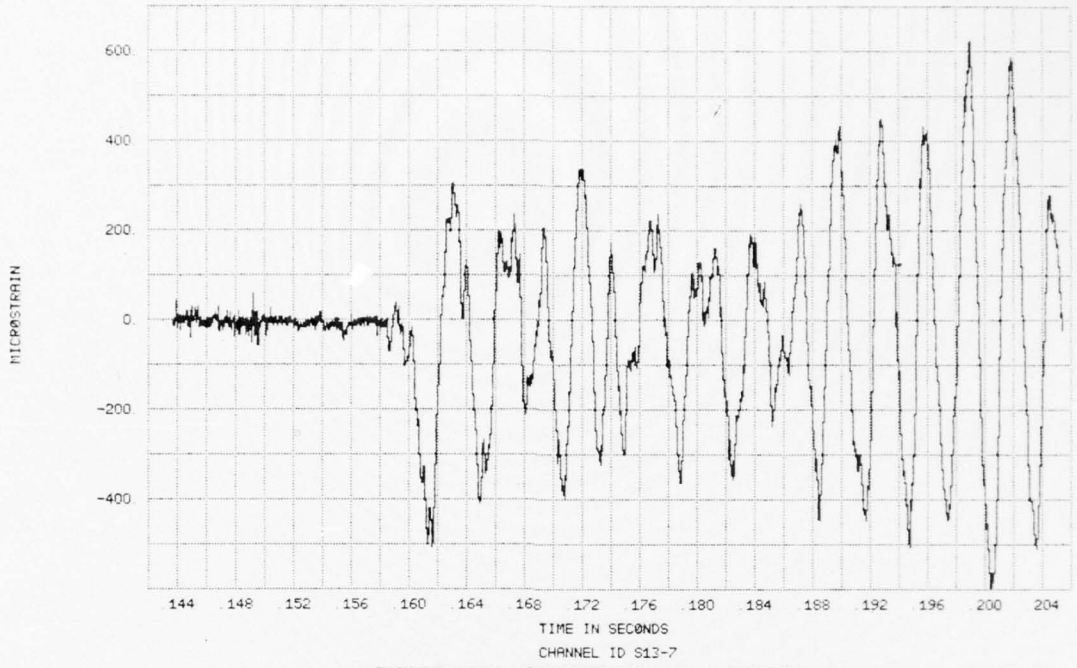


FIGURE 13-57 , SPECIMEN NO. 13 , SHOT NO. 6 ,
STRAIN TIME HISTORY

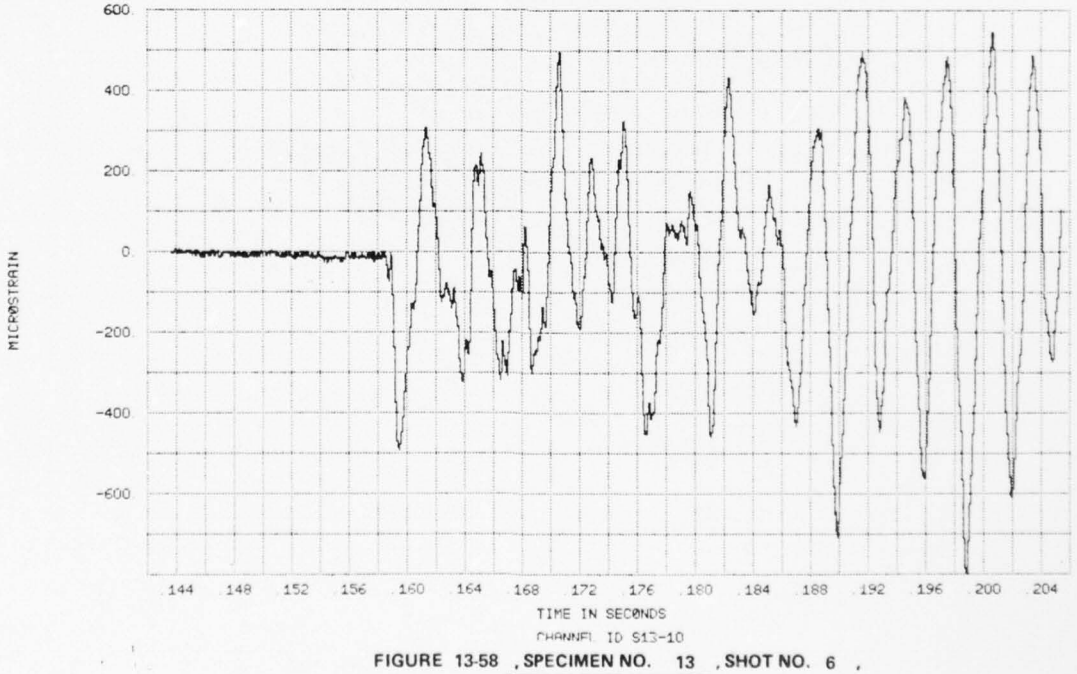


FIGURE 13-58 , SPECIMEN NO. 13 , SHOT NO. 6 ,
STRAIN TIME HISTORY

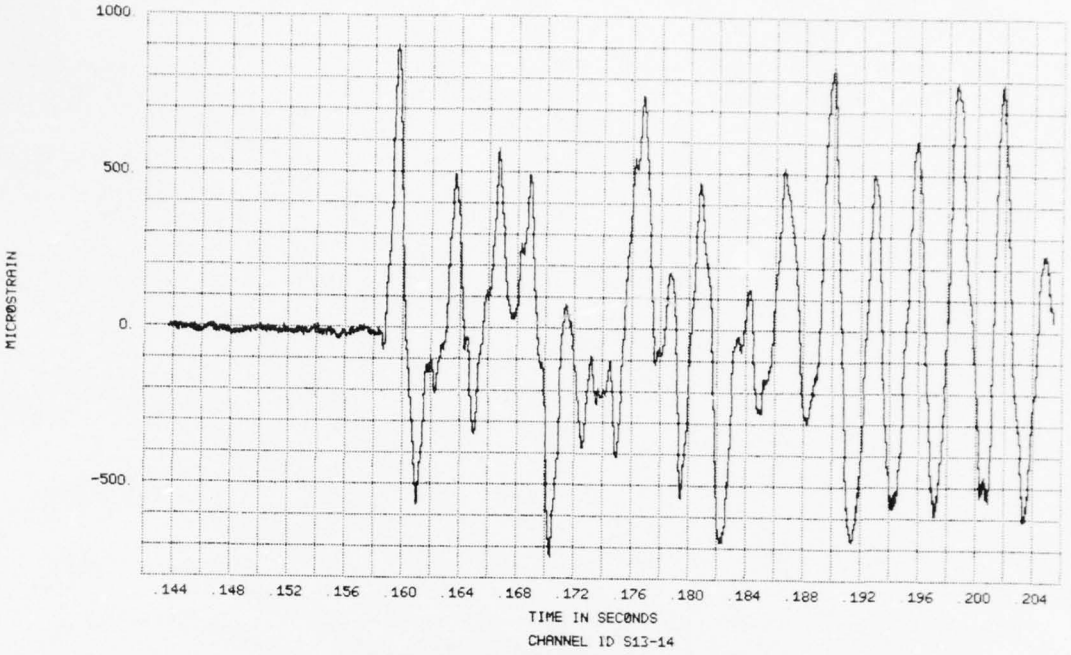


FIGURE 13-59 , SPECIMEN NO. 13 , SHOT NO. 6 ,
STRAIN TIME HISTORY

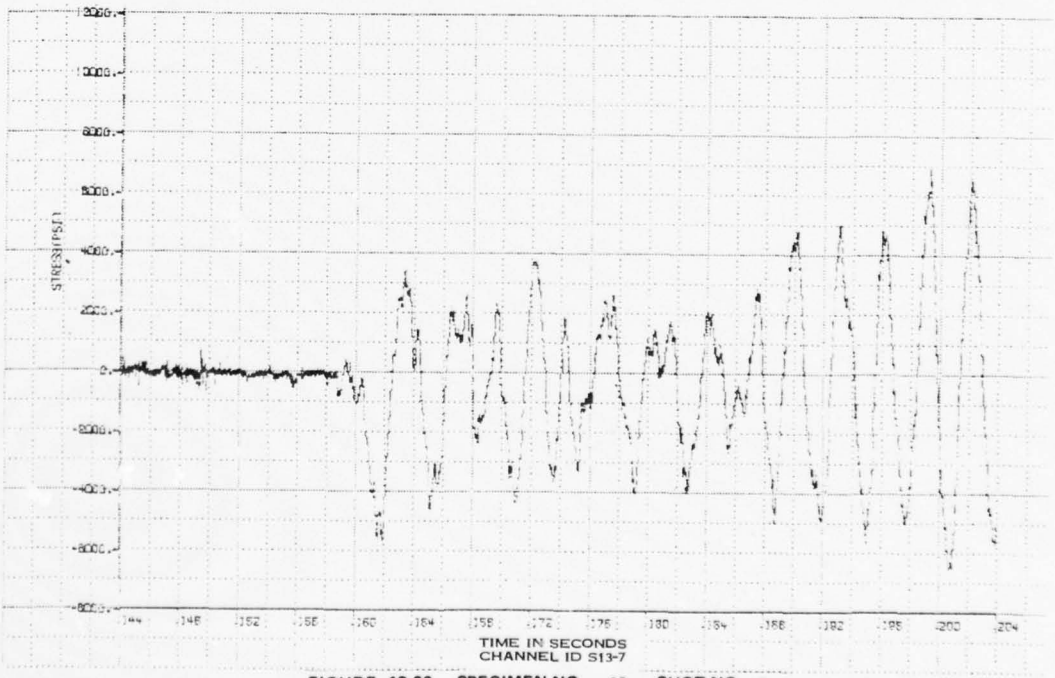


FIGURE 13-60 , SPECIMEN NO. 13 , SHOT NO. 6 ,
STRESS TIME HISTORY

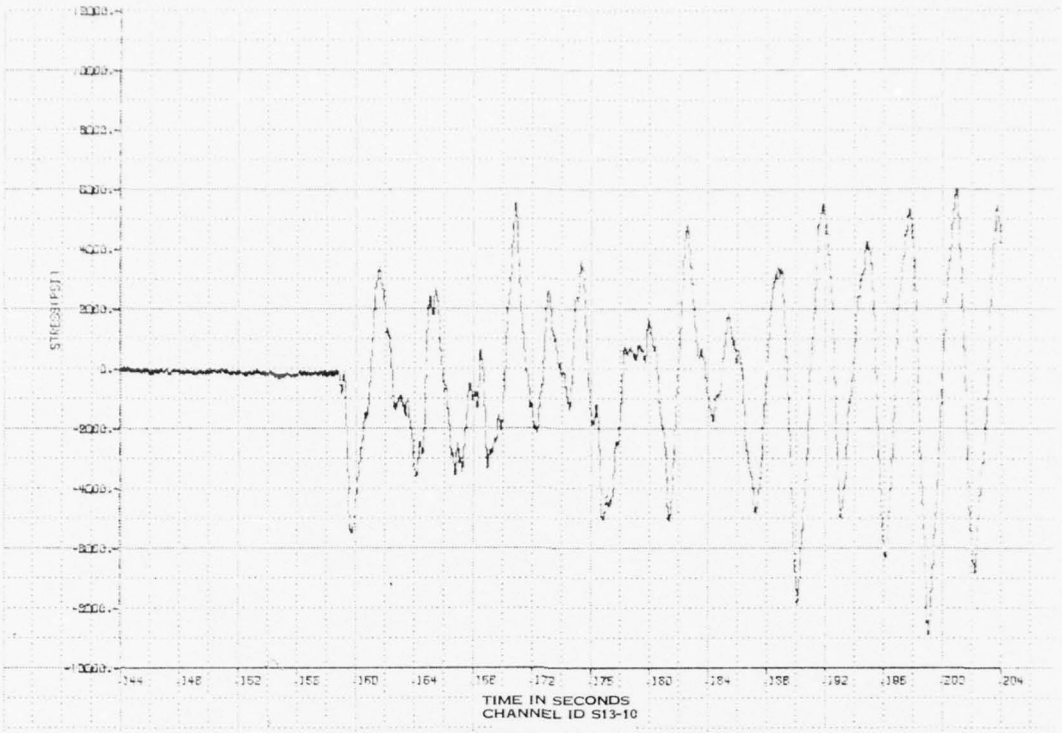


FIGURE 13-61 , SPECIMEN NO. 13 , SHOT NO. 6 ,
STRESS TIME HISTORY

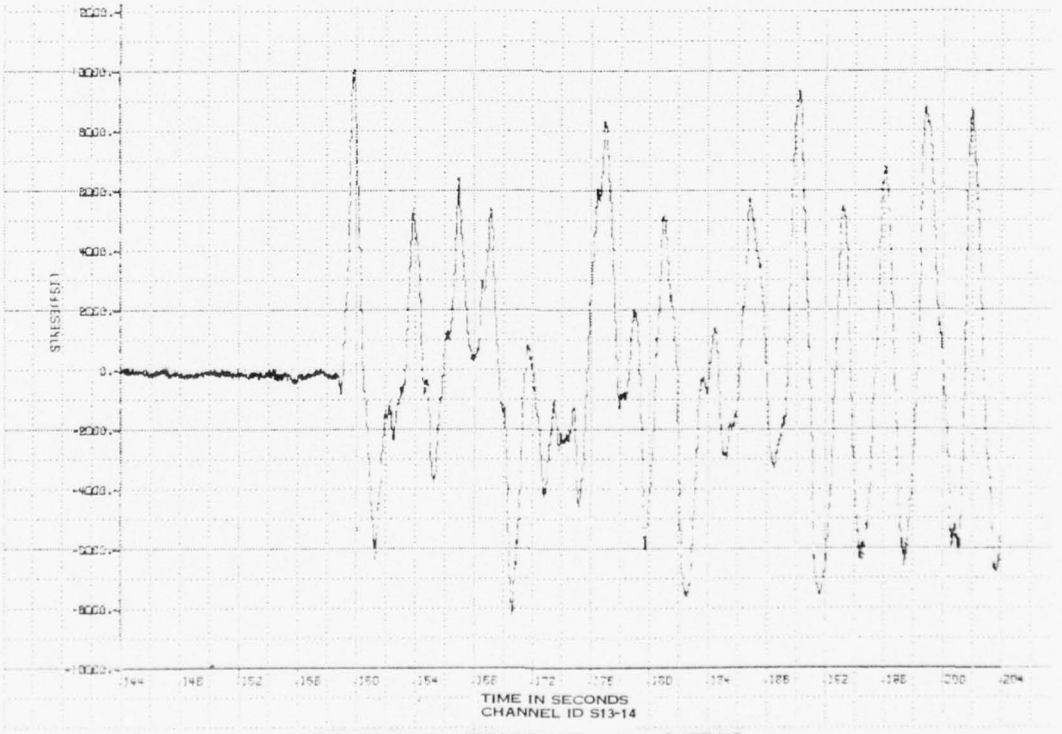


FIGURE 13-62 , SPECIMEN NO. 13 , SHOT NO. 6 ,
STRESS TIME HISTORY

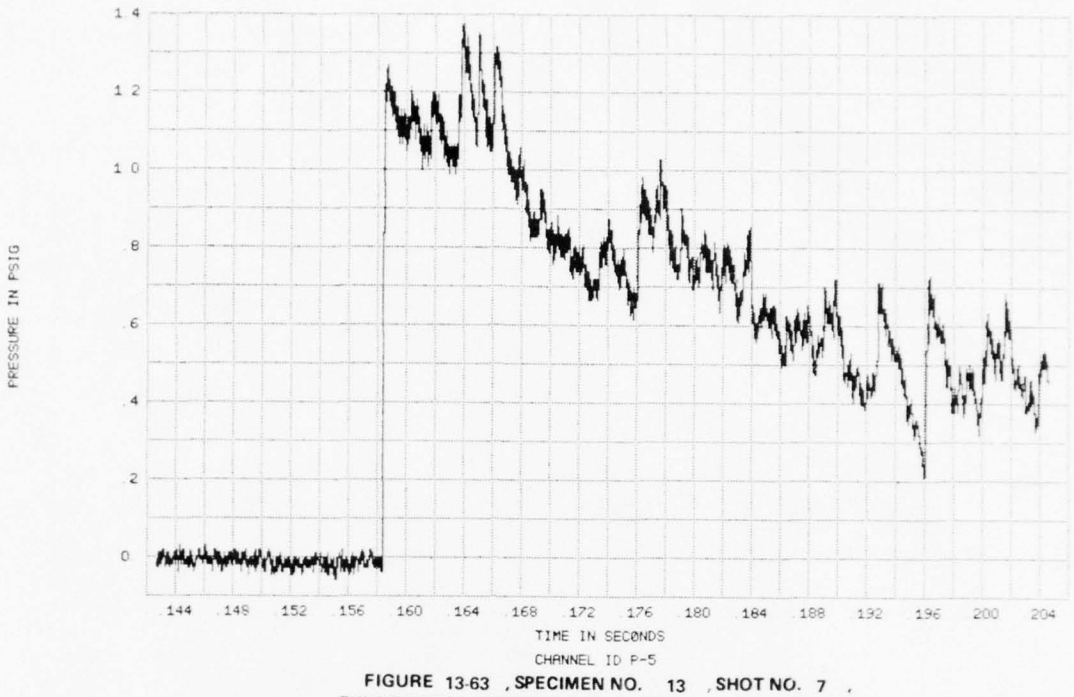


FIGURE 13-63 , SPECIMEN NO. 13 , SHOT NO. 7 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

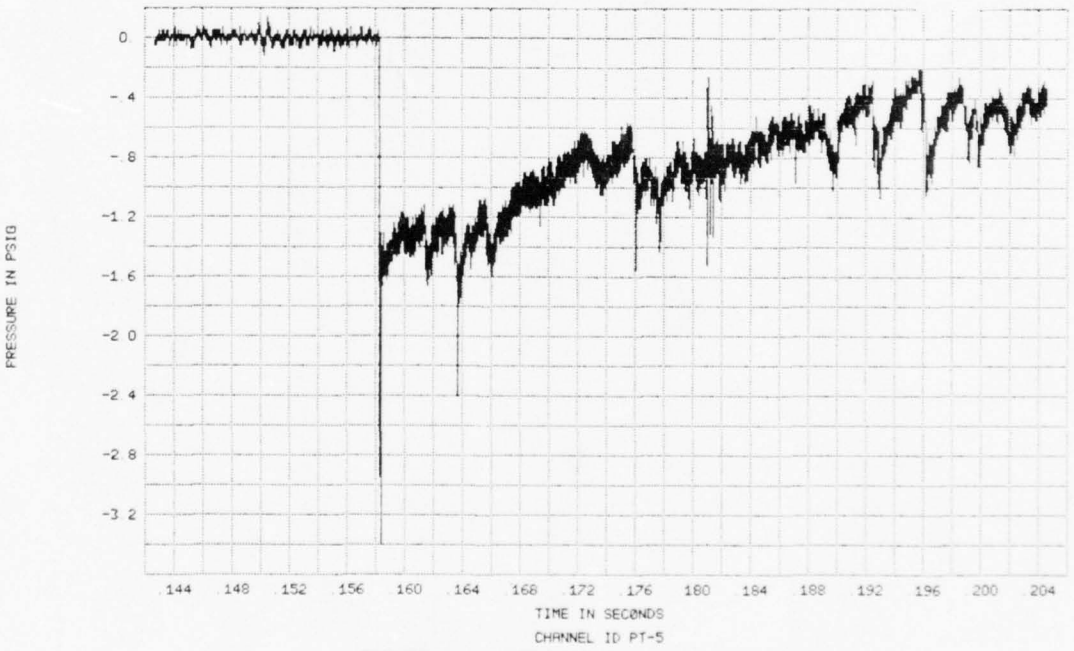


FIGURE 13-64 , SPECIMEN NO. 13 , SHOT NO. 7 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

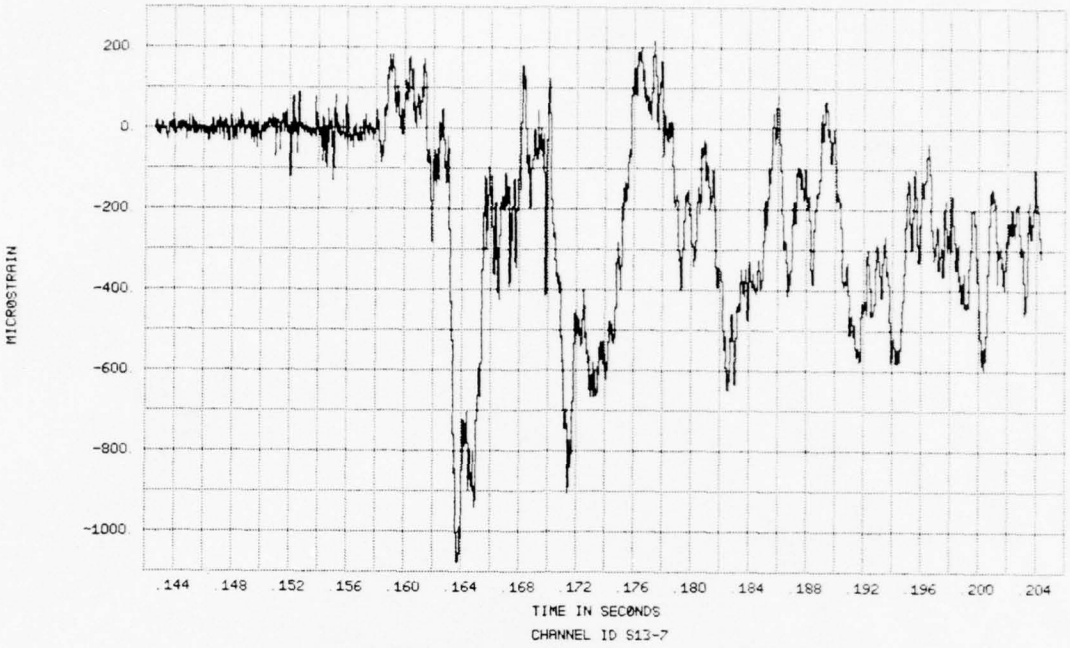


FIGURE 13-65 , SPECIMEN NO. 13 , SHOT NO. 7 , STRAIN TIME HISTORY

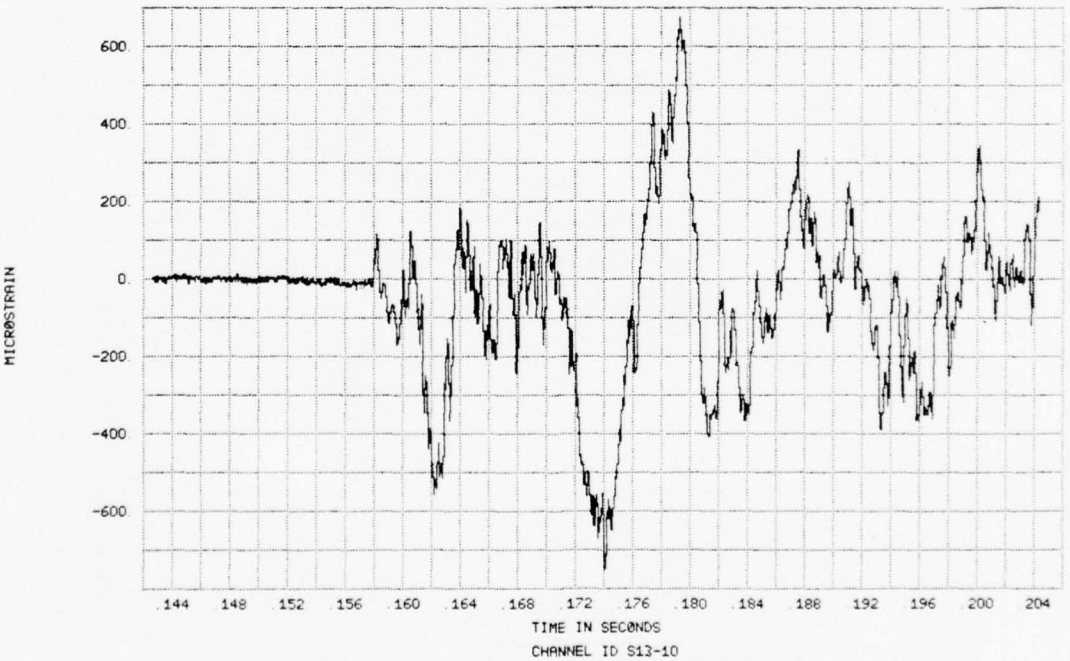


FIGURE 13-66 , SPECIMEN NO. 13 , SHOT NO. 7 , STRAIN TIME HISTORY

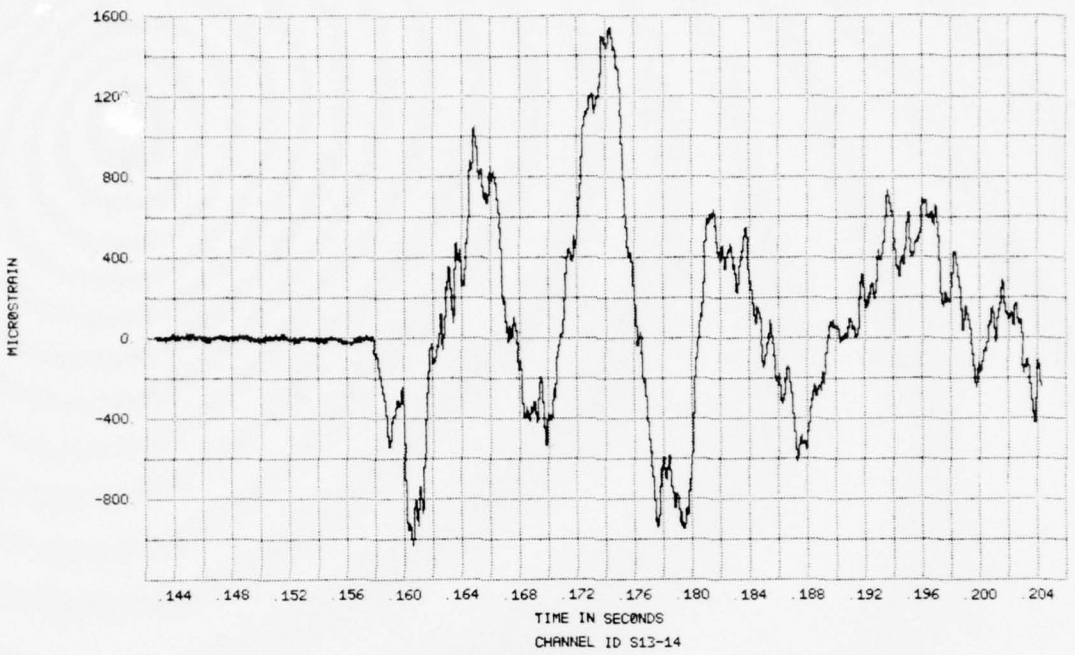


FIGURE 13-67 , SPECIMEN NO. 13 , SHOT NO. 7 ,
STRAIN TIME HISTORY

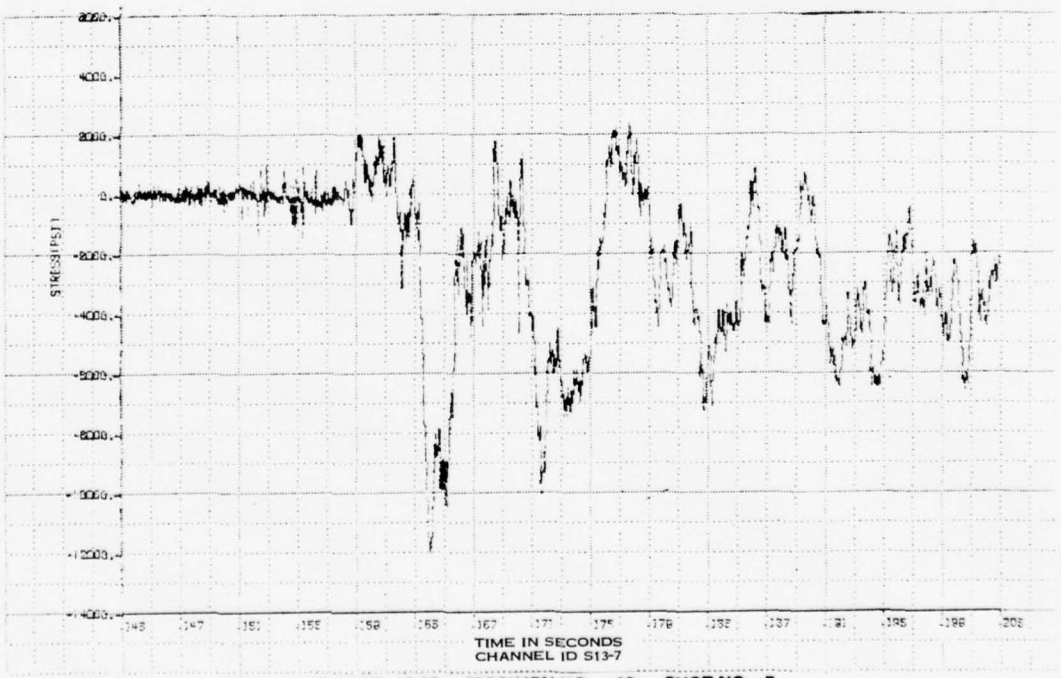


FIGURE 13-68 , SPECIMEN NO. 13 , SHOT NO. 7 ,
STRESS TIME HISTORY

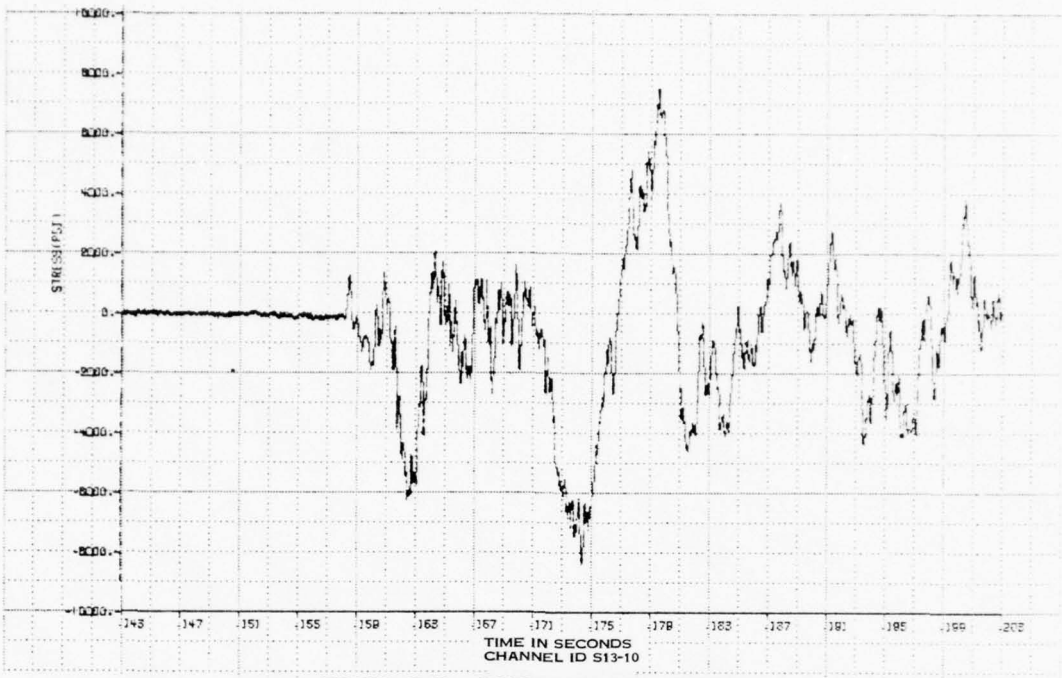


FIGURE 13-69 , SPECIMEN NO. 13 , SHOT NO. 7 ,
STRESS TIME HISTORY

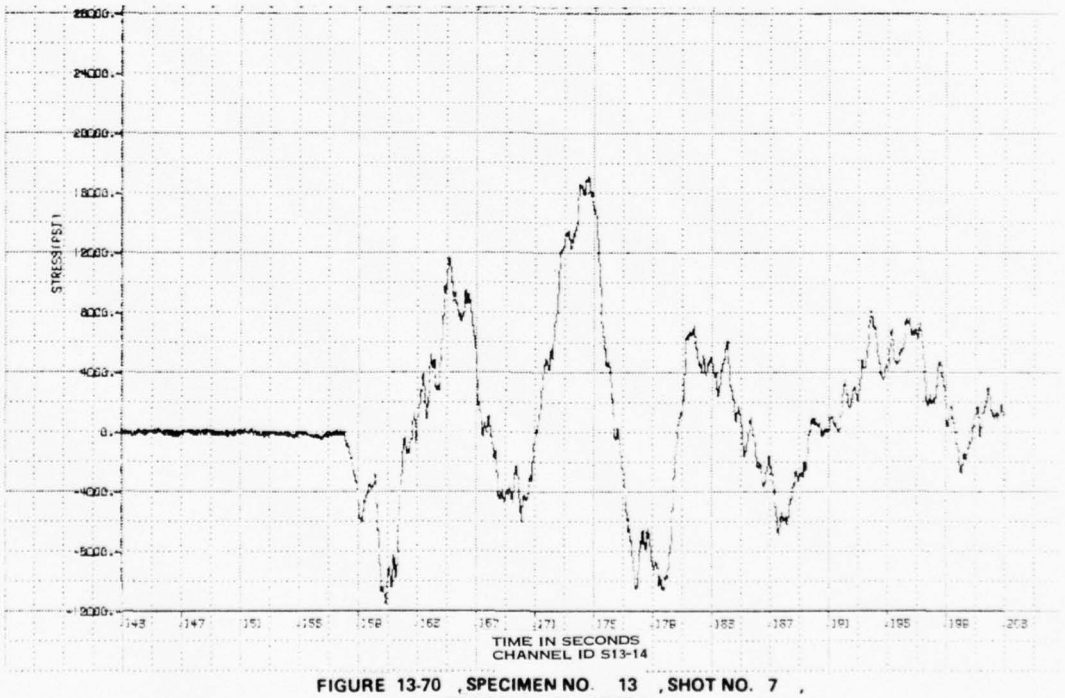


FIGURE 13-70 , SPECIMEN NO. 13 , SHOT NO. 7 ,
STRESS TIME HISTORY

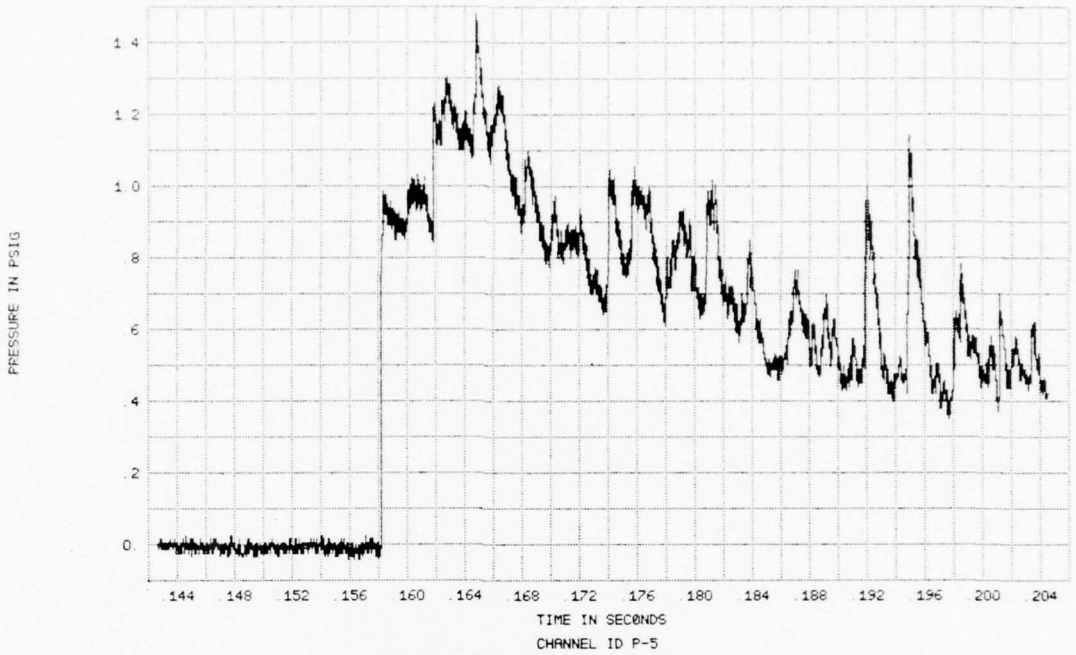


FIGURE 13-71 , SPECIMEN NO. 13 , SHOT NO. 8 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

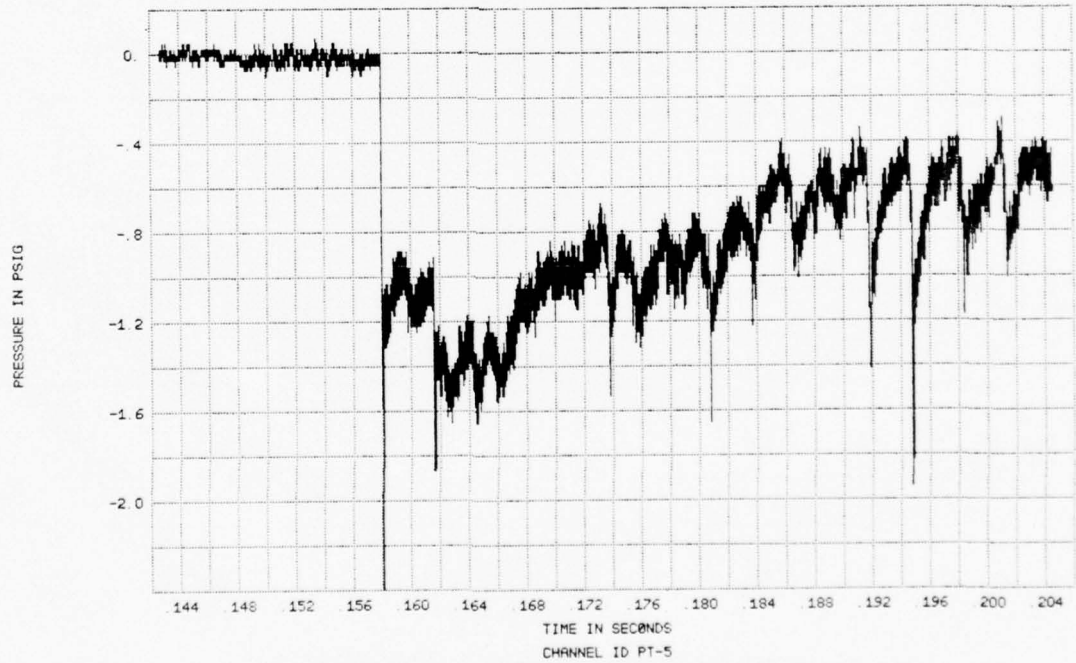


FIGURE 13-72 , SPECIMEN NO. 13 , SHOT NO. 8 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

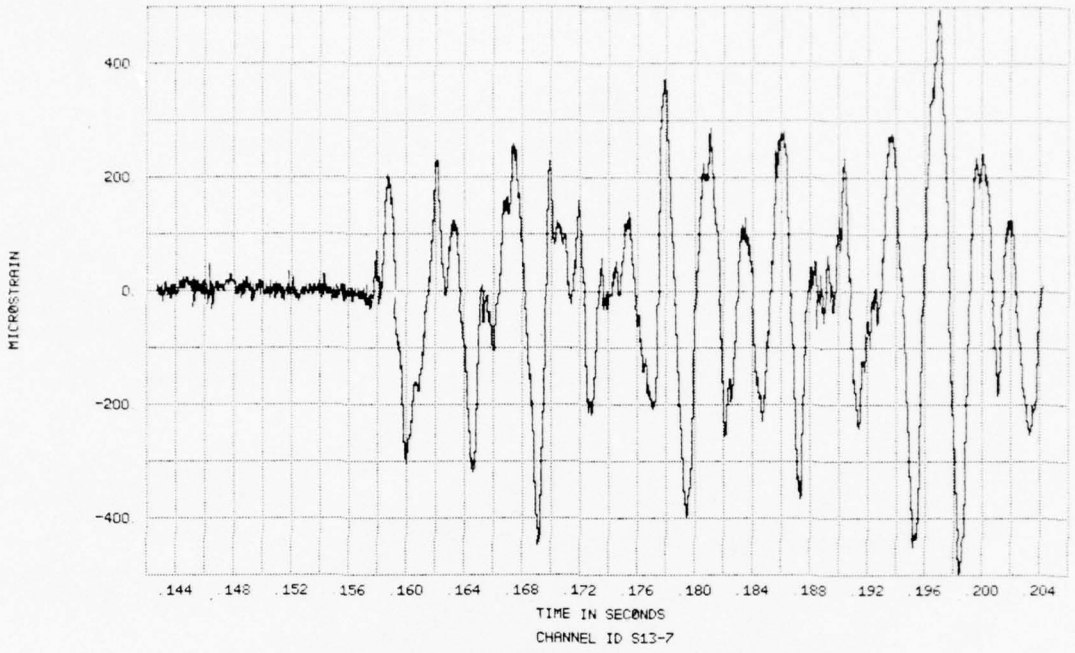


FIGURE 13-73 , SPECIMEN NO. 13 , SHOT NO. 8 ,
STRAIN TIME HISTORY

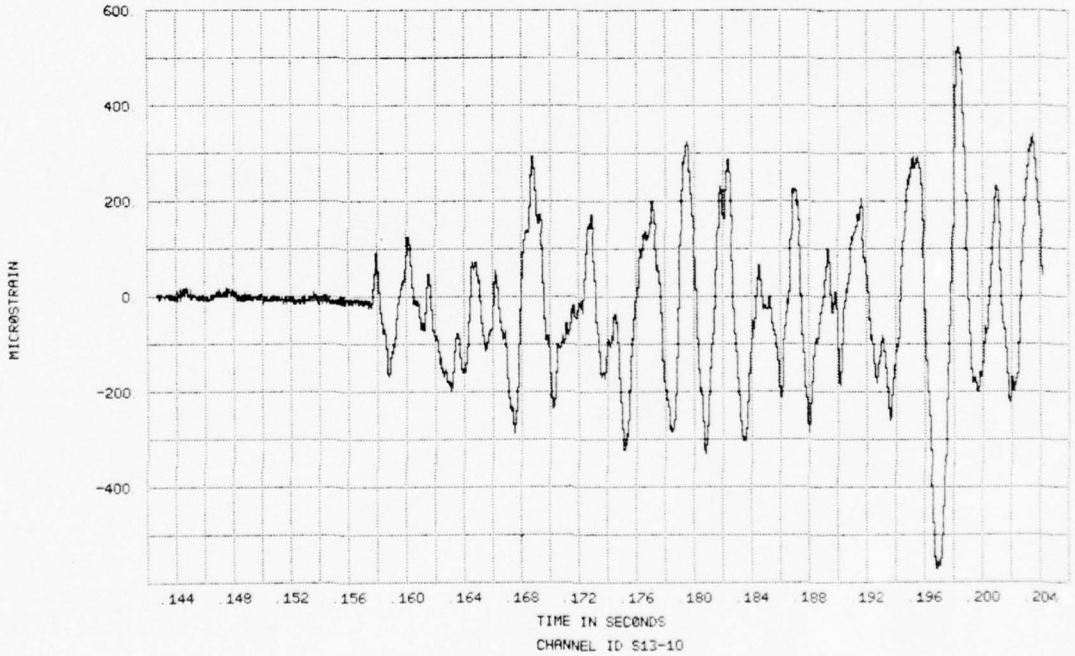


FIGURE 13-74 , SPECIMEN NO. 13 , SHOT NO. 8 ,
STRAIN TIME HISTORY

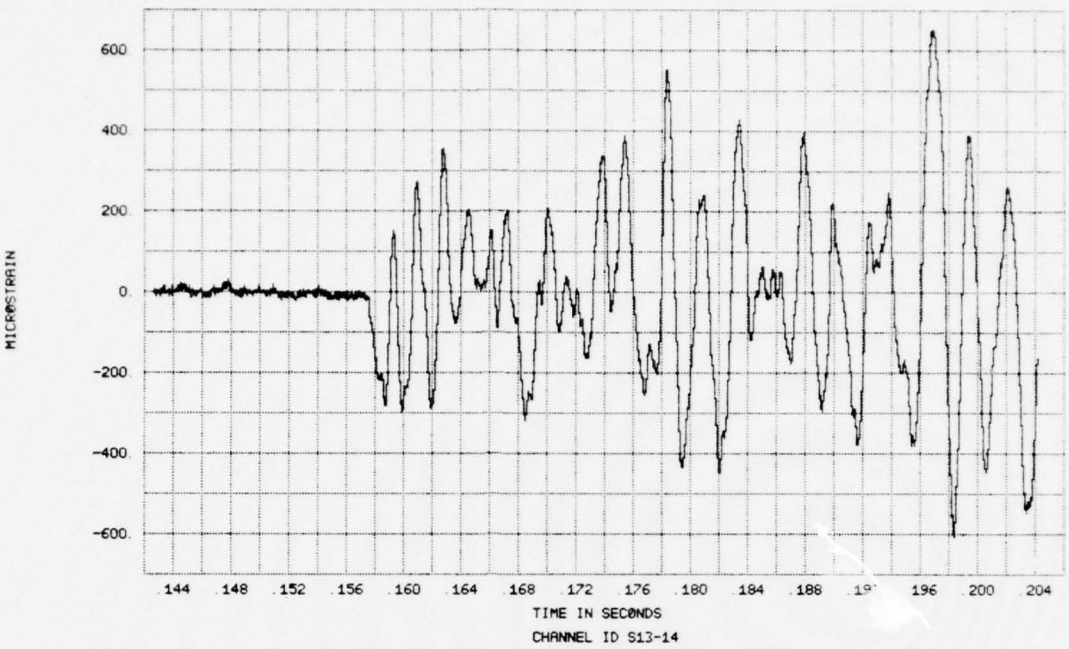


FIGURE 13-75 , SPECIMEN NO. 13 , SHOT NO. 8 ,
STRAIN TIME HISTORY

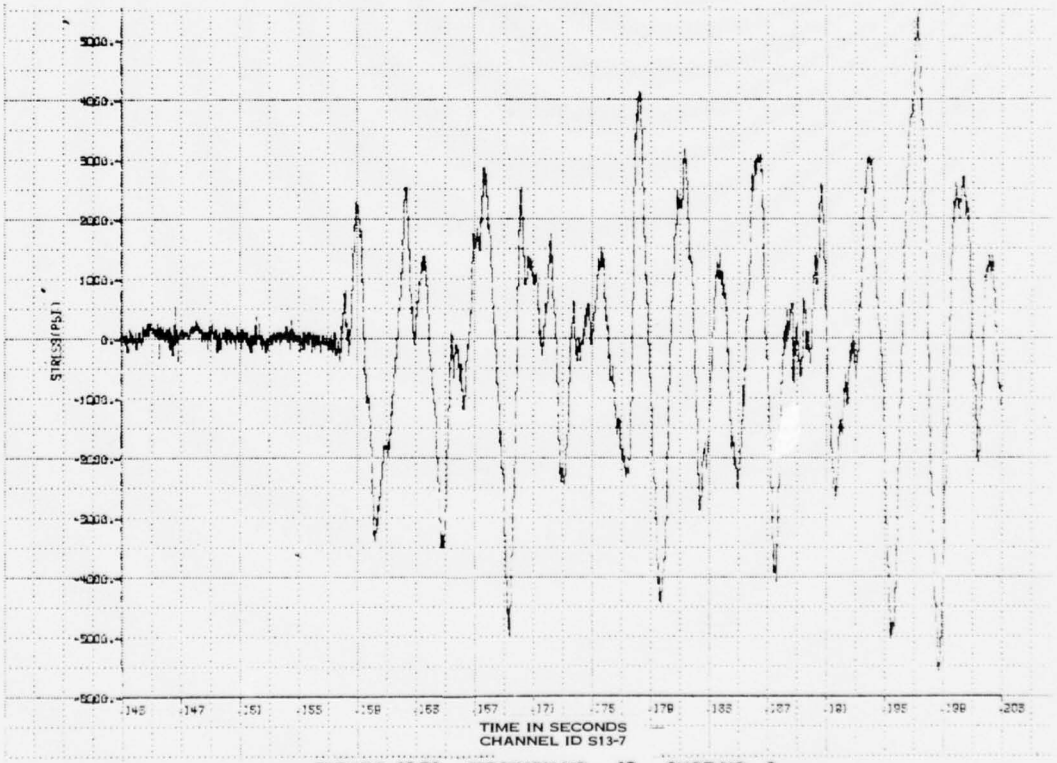


FIGURE 13-76 , SPECIMEN NO. 13 , SHOT NO. 8 ,
STRESS TIME HISTORY

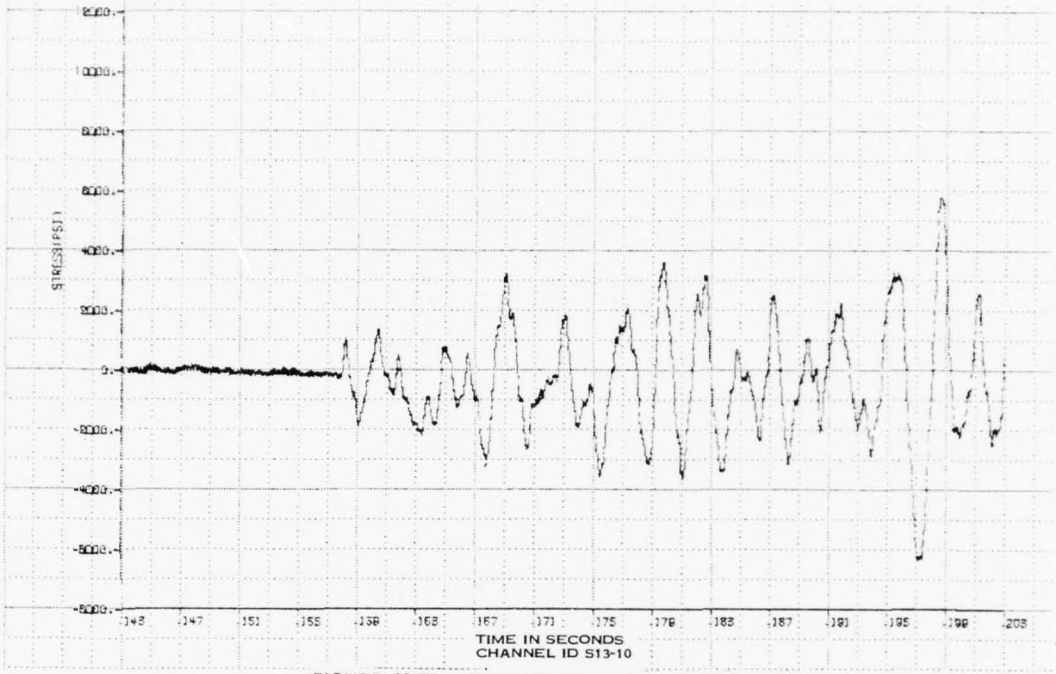


FIGURE 13-77 , SPECIMEN NO. 13 , SHOT NO. 8 ,
STRESS TIME HISTORY

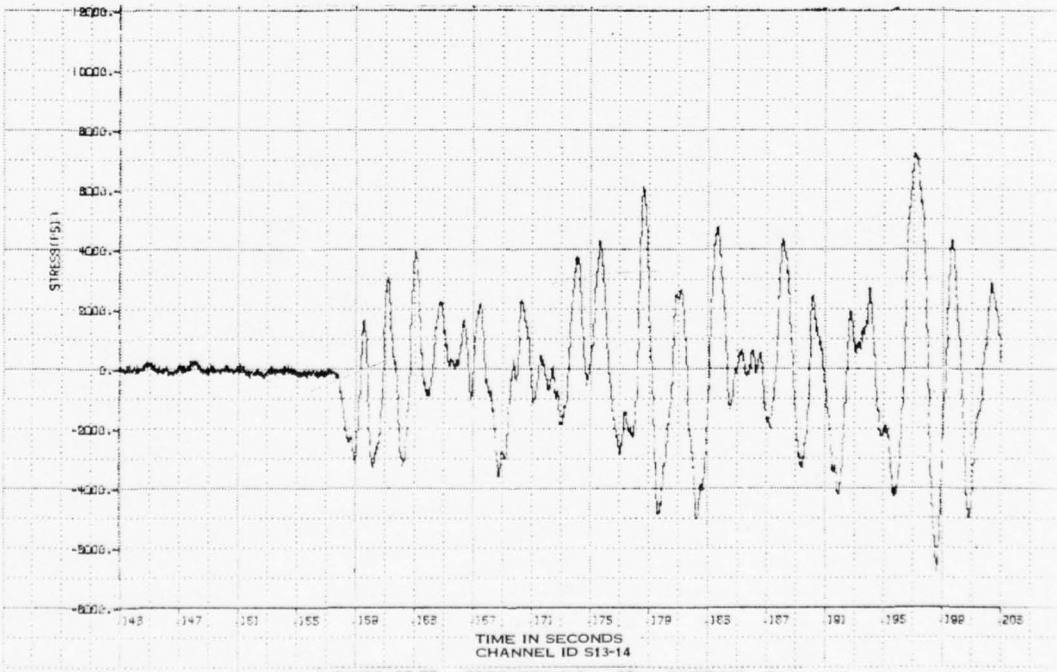


FIGURE 13-78 , SPECIMEN NO. 13 , SHOT NO. 8 ,
STRESS TIME HISTORY

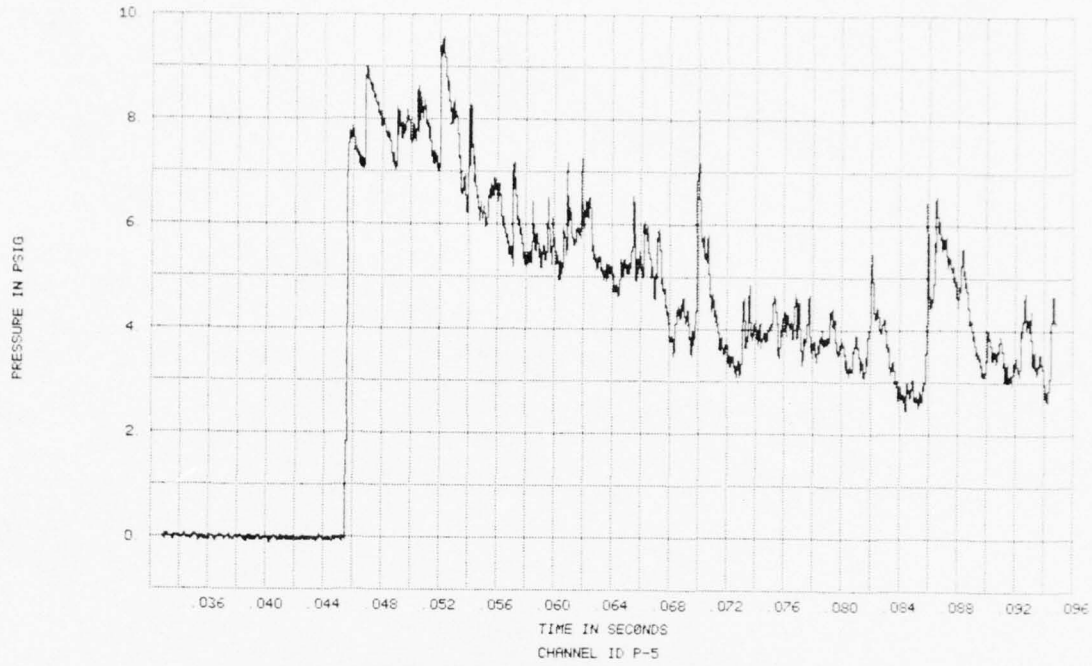


FIGURE 13-79 , SPECIMEN NO. 13 , SHOT NO. 9
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

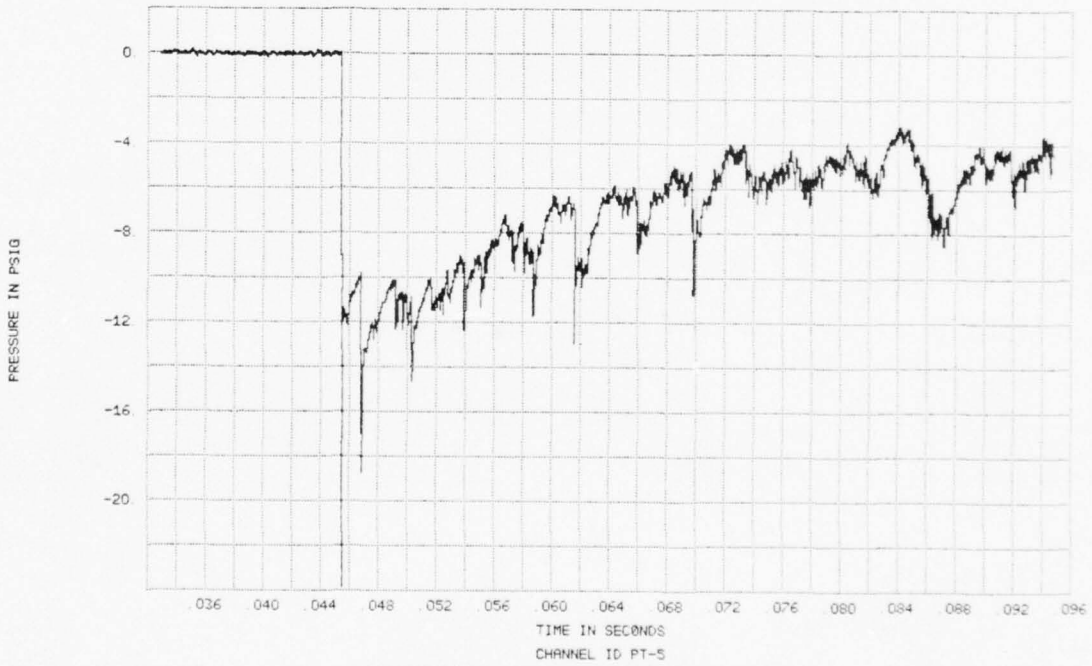
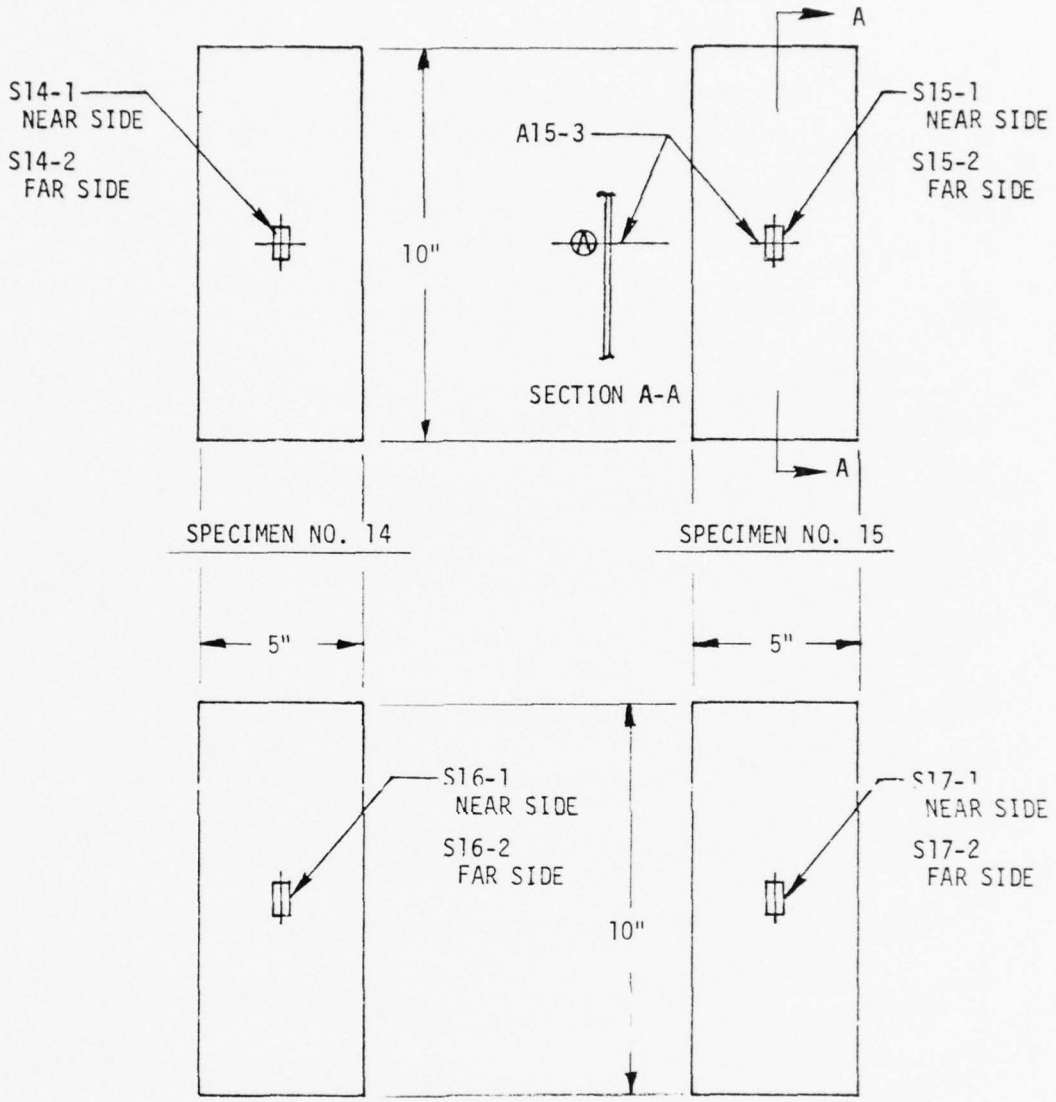


FIGURE 13-80 , SPECIMEN NO. 13 , SHOT NO. 9
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY



FIXED-END COLUMNS - .031 IN. THICK

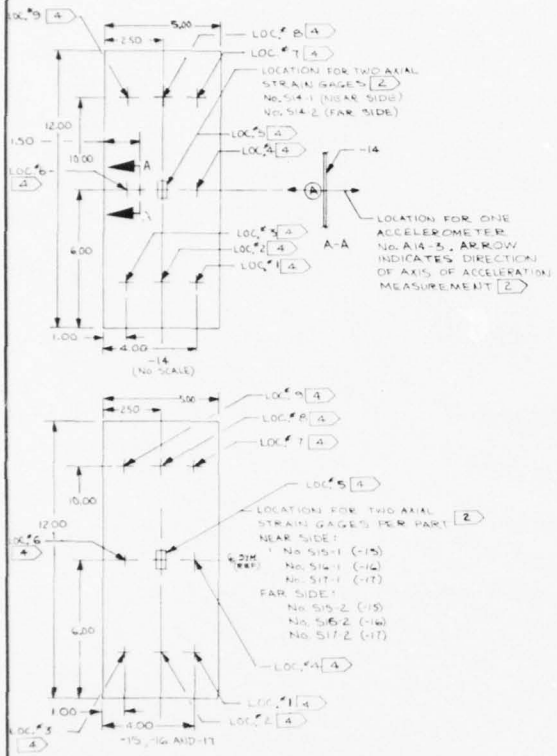
MATERIAL - 7075-T6 ALUMINUM ALLOY

DENSITY - .000262 lb-sec^2/in^4

STRESS/STRAIN DATA

MODULUS OF ELASTICITY - 10.5 x 10^6 PSI } MIL-HDBK-5

F_{ty} - 70,500 PSI



1 RUBBER STAMP NOTE: PRIOR TO INSTALLATION OF GAGES AND MEASUREMENTS PER 4 PARTS ARE UNDISTINGUISHABLE AND MAY BE RANDOMLY PART MARKED.

2 TO BE INSTALLED BY INSTRUMENTATION PERSONNEL. THIS INCLUDED NO. ON PICTURE IS TO BE USED FOR RECORDING TEST DATA AT THIS LOCATION.

3 .040 CLAD 7075-T6 SH. PER A-250/3 CHEM. MILL THICKNESS TO .022/.026 PER BAC 5778 AND RECORD THICKNESSES PER 4 F.2.10

4 AFTER CHEM. MILLING AND PRIOR TO INSTRUMENTATION FILL IN THE FOLLOWING TABLE AND SEND A COPY TO DALE PIERSON (7581) PHONE EXT 2831.

PART No.	THICKNESS (MEASURED TO WITHIN ±.001) LOCATION (±.25) #1	#2	#3	#4	#5	#6	#7	#8	#9
-14									
-15									
-16									
-17									

5 BREAK SHARP EDGES PER BAC 5500

REVISIONS SYM	ZONE	DESCRIPTION	DATE	APPROVAL

RELEASE	QTY REQD	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	ZONE	MATERIAL AND SPECIFICATION	HT TR	FINISH	PT MK	REV LTR
	1	-17	SPECIMEN "17		4		F.2.10		
	1	-16	SPECIMEN "16		4		F.2.10		
	1	-15	SPECIMEN "15		4		F.2.10		
	1	-14	SPECIMEN "14		4		F.2.10		

LIST OF MATERIAL

EX 5032	TEST		TEST SPECIMEN No. 17	-17		EX 5031	
EX 5032	TEST		TEST SPECIMEN No. 16	-16		EX 5031	
EX 5032	TEST		TEST SPECIMEN No. 15	-15		EX 5031	
EX 5032	TEST		TEST SPECIMEN No. 14	-14		EX 5031	
NEXT ASSY	USED ON	SECTION	SERIAL NUMBER	PART NUMBER	RELEASE COLUMN INDICATOR	DRAWING SHEET NUMBER	REV LTR
APPLICATION							

DIMENSIONING & TOLERANCING PER USAS Y14.5
FORM, PUNCH, STRAIGHTEN & FIT METAL PARTS PER BAC5300
MATERIAL SUBSTITUTION & EQUIVALENTS PER BAC5005
SST. MATERIALS SUBSTITUTIONS & MANUFACTURING PROCESSES PER D6-19776
BOLT & NUT INSTALLATION PER BAC5009
PART MARKING PER BAC5307
RIVET INSTL & SYM PER BAC5004
SEE BACD 2097 FOR SURFACE ROUGHNESS
FOR FINISH CODES, SEE DOCUMENT D2-5000 & OR D6-5000

CHANGE NO. EEO 59-7403-0001
DWG ORIG BY (GROUP) B-52 STRUCTURES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ANGLES ±° DECIMALS ± .03
RIVET & BOLT EDGE MARGINS ± .05
SHEET METAL CORNER RADII INTERNAL 16 19 / 16 EXTERNAL 32 25 / 00
BEND RADII ± .11 ON .03 & .06 ± .03 ON .09 & GREATER

DRAWN [illegible] DATE 7-10-72
CHECKED [illegible] 7-10-72
STRESS [illegible] 7-10-72
ENGR [illegible] 7-10-72
GROUP [illegible] 7-10-72
PROJ [illegible] 7-10-72

THE BOEING COMPANY
COMMERCIAL AIRPLANE DIVISION RENTON, WASH.

SPECIMEN - COLUMNS No. 14, 15, 16 AND 17 STRESS NO

CODE IDENT NO. 81205 SIZE D EX 5031

SCALE SHT 1 OF 1

DRAWING RECORDS COPY

D1 5007-2020 ORIG 1/72

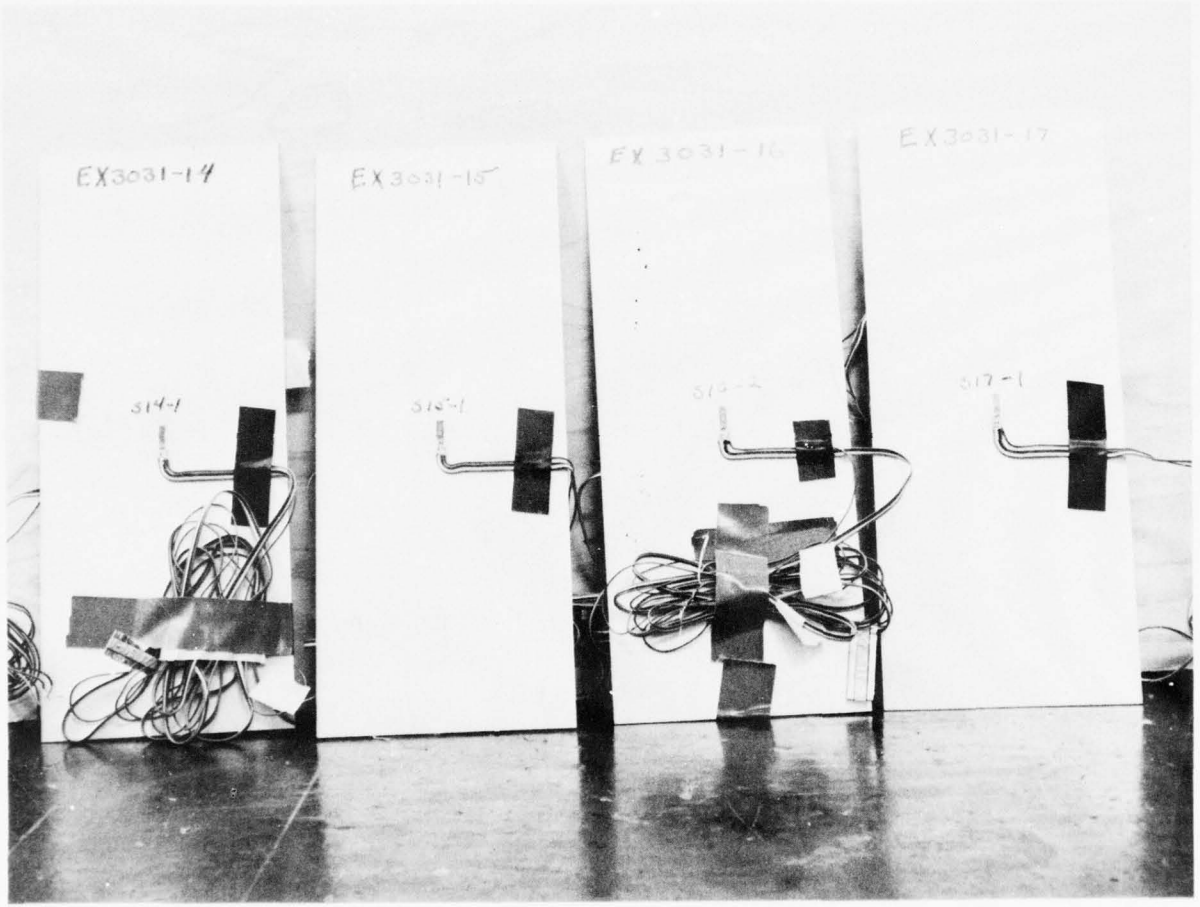


FIGURE 14-1 - SPECIMEN NO. NOS. 14 THRU 17 - INSTRUMENTATION ON ONE SIDE

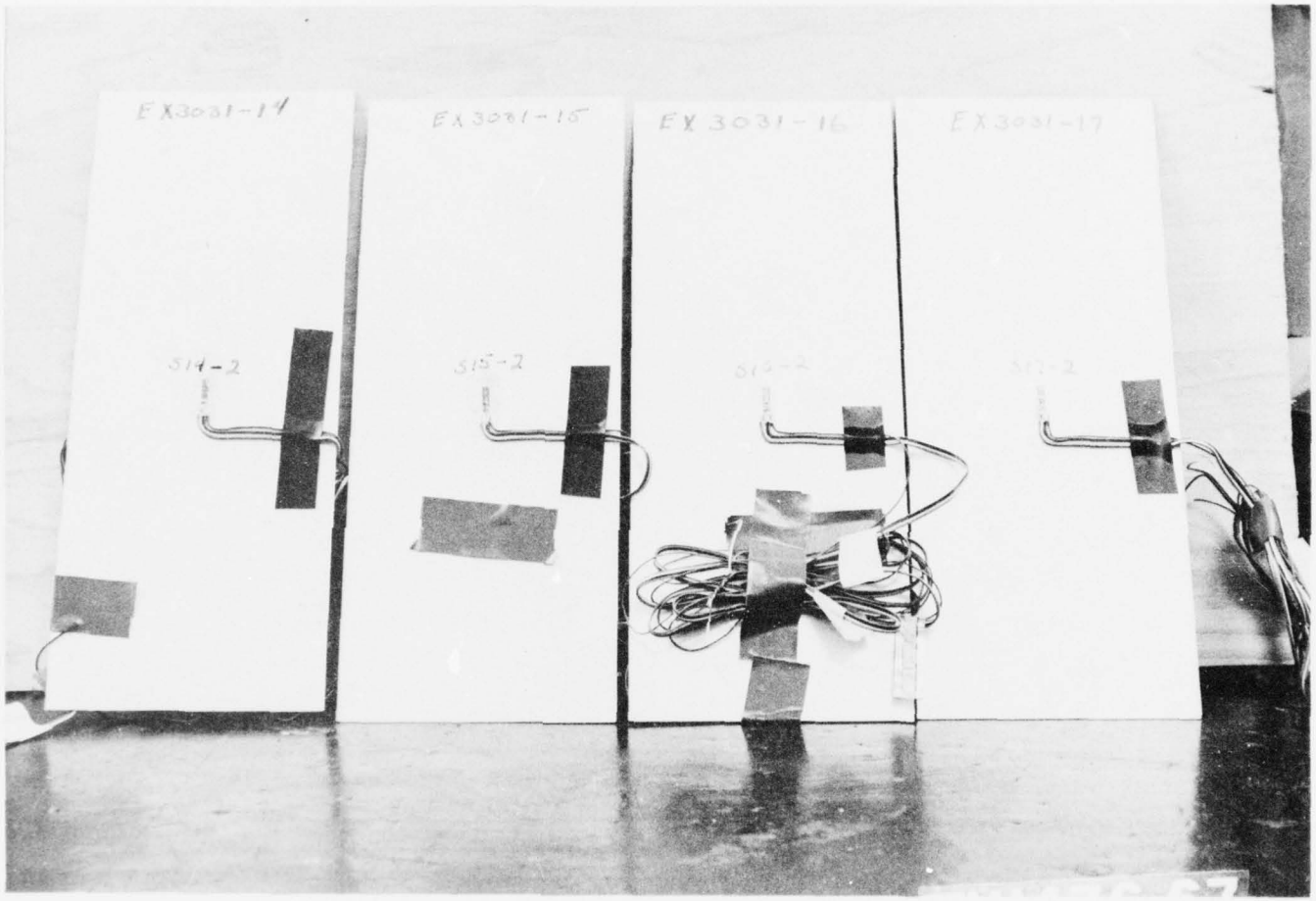


FIGURE 14-2 - SPECIMEN NO. NOS. 14 THRU 17 - INSTRUMENTATION ON OPPOSITE SIDE

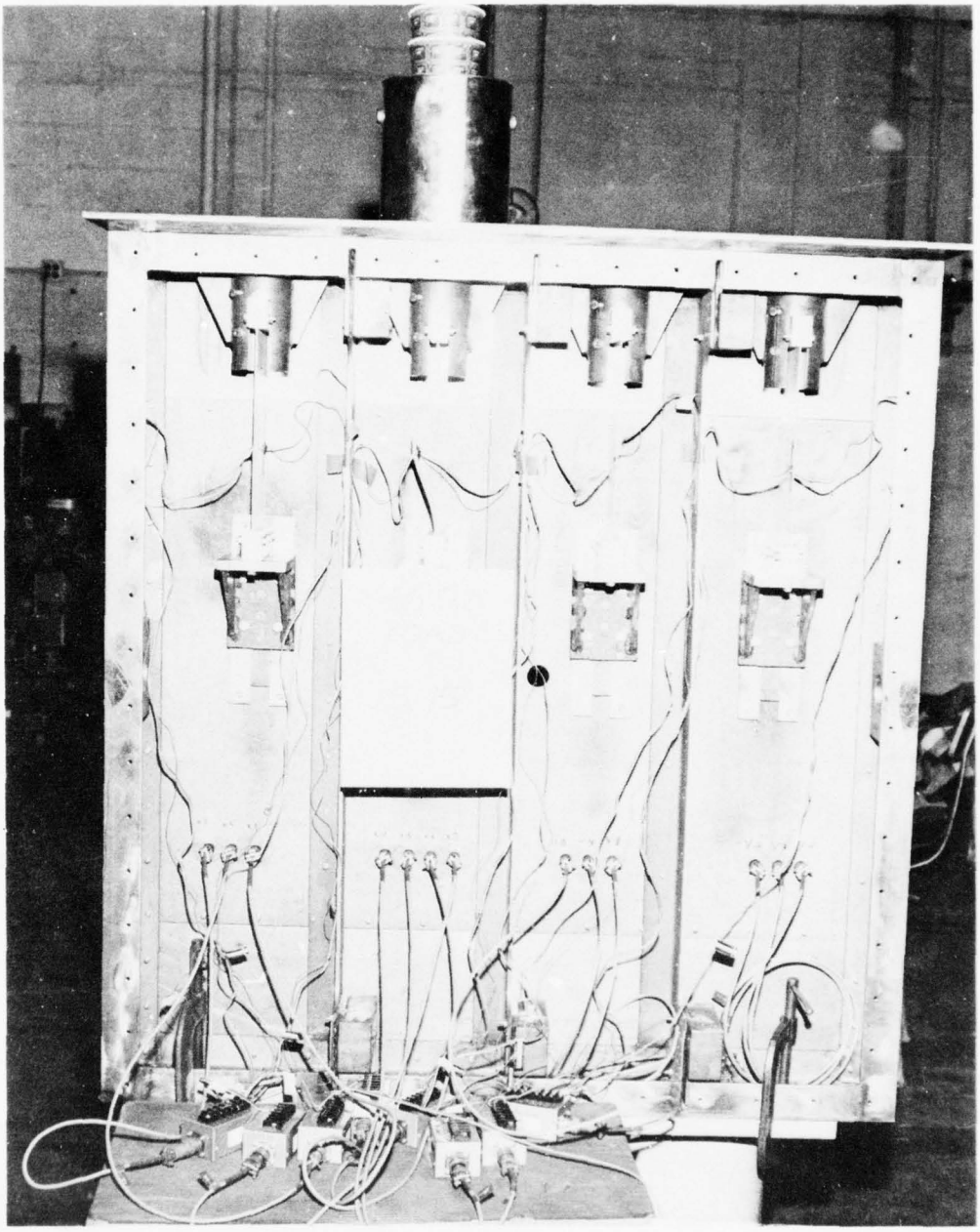


FIGURE 14-3 - SPECIMEN NOS. 14 THRU 15 - SPECIMEN NO. 15 - DEFORMED UNDER LOAD

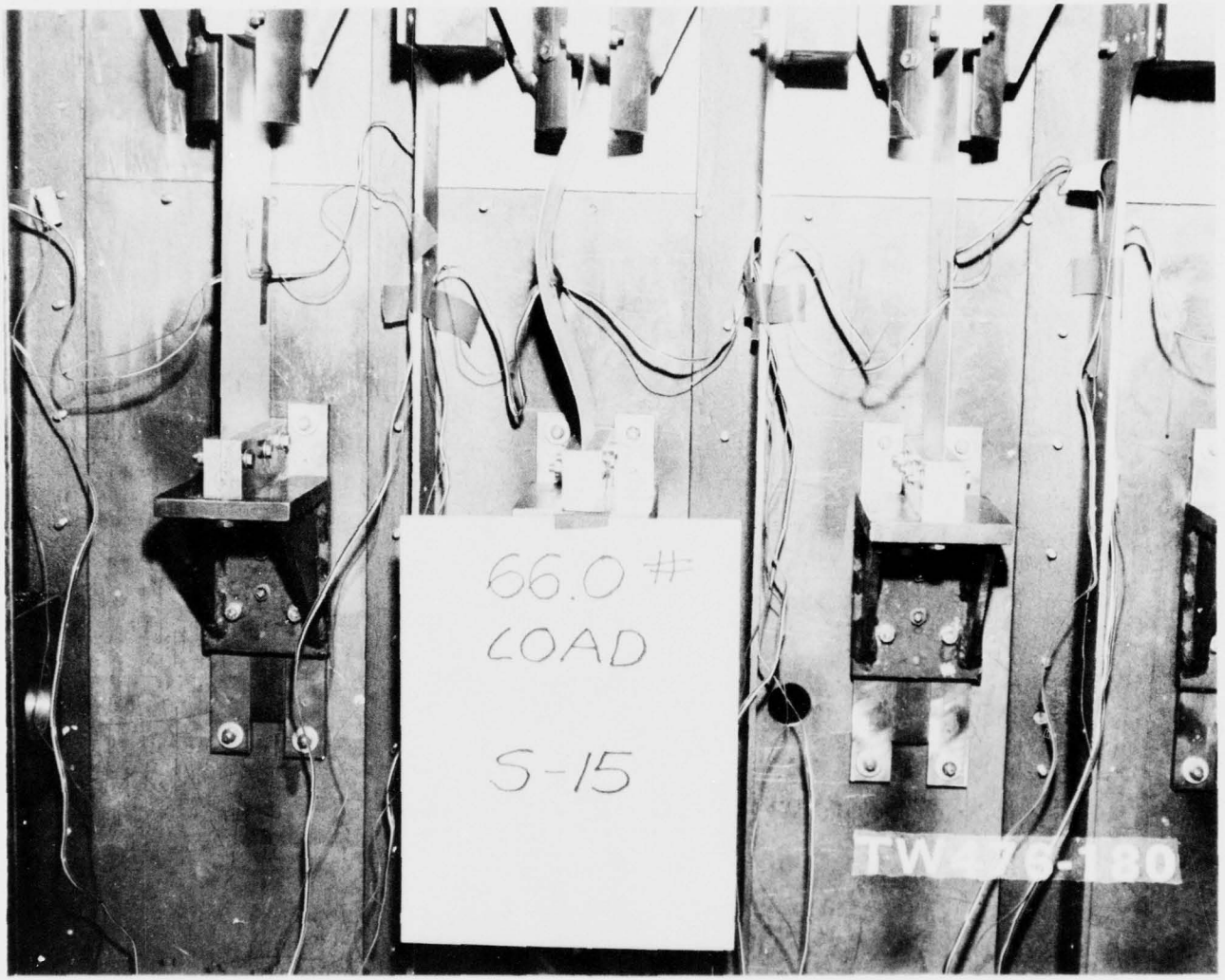


FIGURE 14-4 - SPECIMEN NO. 15 - CLOSE-UP OF DEFORMATION UNDER LOAD

Test Specimen No. 14-17

Test specimens 14-17 were buckling-sensitive columns. As indicated in Reference 1, the NOVA-2 computer program is not capable of analyzing this type of structural element under static load. Therefore, the derivation of the static analysis for these specimens is presented below.

NOTE: The columns were loaded by pistons which displaced down a cylinder as the external load was applied. The area of the pistons was 4.91 in^2. Therefore, the width over which the pressure acts was set = 0.9818 inches, such that 0.9818 x width = 0.9818 x 5 = 4.91 in^2.

Based on pretest measurements, the columns exhibited the following lateral initial imperfections at their respective centers:

Test Spec. No. 14		0.0 inches
Test Spec. No. 15	-	0.01 inches
Test Spec. No. 16		0.0 inches
Test Spec. No. 17	-	0.03 inches

Buckled Columns - Load/Stress/Deflection Derivation

It is desired to examine the strength and displacement of long columns ($L/\rho > 70$) beyond the point of buckling. To do so, the knowledge of the deflected shape and the minimum radius of curvature is required. From this knowledge, the maximum deflection, lateral and axial, and the maximum stress, bending and axial, can be computed.

It is known that pin-ended columns buckle to a half-sine wave shape and fixed-ended columns buckle to a full sine wave. It is also known that bending moments can be computed from the formula.

$$\frac{1}{R} = \frac{M}{EI} \quad \text{or} \quad M = \frac{EI}{R}$$

where:

R = Radius of curvature of the elastic curve
M = Bending moment
E = Modulus of elasticity
I = Moment of inertia

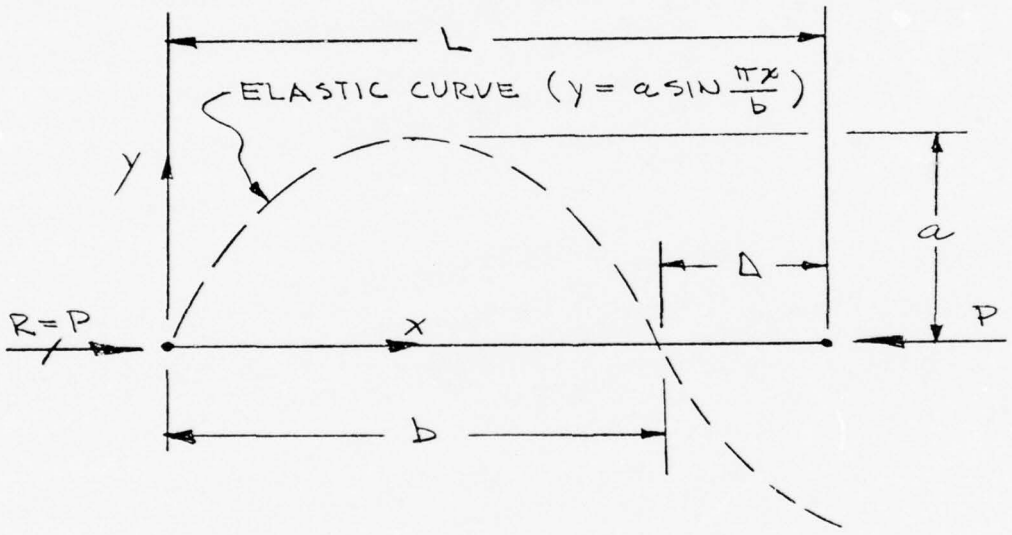
The basic equation for a sine curve is

$$y = a \sin \frac{\pi x}{b}$$

where:

y = Ordinate
x = Abscissa
a = Single amplitude
b = Length of a half wave

See the following sketch for application of this formula



M_{max} occurs at $x = \frac{b}{2}$; $M_{max} = Pa$ and

$R = \frac{EI}{M} = \frac{EI}{Pa}$

$$\text{but } R = \frac{ds}{d\theta} = \frac{\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{3/2}}{-\frac{d^2y}{dx^2}} \quad *$$

differentiating $y = a \sin \frac{\pi x}{b}$

$$\frac{dy}{dx} = \frac{\pi a}{b} \cos \frac{\pi x}{b}$$

and

$$-\frac{d^2y}{dx} = \frac{\pi^2 a}{b^2} \sin \frac{\pi x}{b}$$

$$R = \frac{\left[1 + \pi^2 a^2 \cos^2 \frac{\pi x}{b}\right]^{3/2}}{\frac{\pi^2 a}{b^2} \sin \frac{\pi x}{b}}$$

since R is desired at $x = \frac{b}{2}$; by substitution,

$$R = \frac{[1 + 0]^{3/2}}{\frac{\pi^2 a}{b^2}(1)} = \frac{b^2}{\pi^2 a} = \frac{EI}{Pa}$$

and

$$P = \frac{EI\pi^2}{b^2}; \quad \text{but, for } \Delta = 0 \text{ and } b = L,$$

$$P = \frac{EI\pi^2}{L^2} \quad \text{which is the Euler buckling load}$$

The above can also be derived by the virtual work method

*"Calculus and Analytical Geometry", Addison and Wesley

$$a = \int_0^{\frac{b}{2}} \frac{M_x\, m}{EI}\, dx$$

Where m is the moment at x due to a 1 lb. load applied in the direction of and at the location of the desired deflection and $M_x = Py$

$$a = \int_0^{\frac{b}{2}} \frac{Py\ x\ dx}{EI} = \frac{Pa}{EI} \int_0^{\frac{b}{2}} x \sin \frac{\pi x}{b}\, dx$$

but $\frac{\pi x}{b} = \theta$ and $dx = \frac{bd\theta}{\pi}$ and $x = \frac{b\theta}{\pi}$

$$1 = \frac{Pb^2}{EI\pi^2} \int_0^{\frac{\pi}{2}} \theta \sin \theta\, d\theta = \frac{Pb^2}{EI\pi^2}$$

and $P = \frac{EI\pi^2}{b^2}$, which is the same as above

Where the allowable maximum displacement, a, is limited by the yield stress, F_{cy}, P_{limit} (OR P_L) can be determined in the following manner:

$$F_{cy} = \frac{P}{A} + \frac{Mc}{I} = \frac{P_L}{A} + \frac{P_L ac}{I}$$

$$OR,\ P_L = \frac{F_{cy}}{\frac{1}{A} + \frac{ac}{I}} \Rightarrow \frac{EI\pi^2}{b^2} = \frac{EI\pi^2}{(L-\Delta)^2}$$

$$\&\ a = \frac{1}{c} \cdot \left[\frac{F_{cy}\,(L-\Delta)^2}{E\pi^2} - \frac{I}{A} \right]$$

In the above formula, all the parameters are known values except a and Δ. It now becomes necessary to establish a relationship between a and Δ.

Assuming that the change in column length due to axial stress is negligible, the length of the sinecurve from 0 to x = L is

$$L_o^b = \frac{2b}{\pi}\sqrt{1+\pi^2C^2}\int\sqrt{1-k^2\sin^2\phi}\;d\phi$$

$$\text{WHERE}\quad C=\frac{a}{b}\quad \&\quad k=\sqrt{\frac{\pi^2C^2}{1+\pi^2C^2}} \qquad *$$

$$\text{OR,}\quad L_o^b = \frac{2bE}{\pi}\sqrt{1+\pi^2C^2}$$

Since b is unknown, it is more useful to write

$$\frac{L_o^b}{b} = \frac{2E}{\pi}\sqrt{1+\pi^2C^2}$$

Where E is the elliptical integral which is tabulated in terms of ARCSIN K in standard mathematical Tables

It is convenient to let $\frac{L}{b} = r$, *and by algebraic manipulation,*

$$\frac{\Delta}{L} = \frac{r-1}{r} \quad \text{and} \quad \frac{a}{\Delta} = \frac{c}{r-1}$$

Note that $\frac{\Delta}{L}$ and $\frac{a}{\Delta}$ are non-dimensionless parameters applicable to any column configuration. Also note that $\frac{\Delta}{L}$ versus $\frac{a}{L}$ could be plotted, but $\frac{a}{\Delta}$ is equally useful and provides a visible relationship of the lateral displacement, a, with the vertical displacement, Δ.

The procedural steps for curve plot are as follows:

1. Assume a value of C
2. Solve $K = \sqrt{\frac{\pi^2C^2}{1+\pi^2C^2}}$
3. Evaluate ARCSIN K
4. Read E from Table (or plot, if preferred)
5. Solve $\frac{L}{b} = r = \frac{2}{\pi} E \sqrt{1+\pi^2 C^2}$

*"Rectification of Plane Curves", B. Saelman, Lockheed Aircraft Company, Burbank, California

6. Solve $\frac{\Delta}{L} = \frac{r-1}{r}$

7. Solve $\frac{a}{\Delta} = \frac{c}{r-1}$

8. Plot $\frac{\Delta}{L}$ versus $\frac{a}{\Delta}$ for various values of C

By varying the range of C, plots can be made to suitable scales. It is recommended that log paper be used. The plots are applicable to either pin-ended or fixed-ended columns, but a, Δ and L should always be consistently representative of total lateral displacement and column total length respectively. The above curve is plotted on Page 654.

By plotting $\frac{a}{\Delta}$ versus $\frac{\Delta}{L}$ from the previously derived formula,

$$a = \frac{1}{c}\left[\frac{F_{cy}(L-\Delta)^2}{E\pi^2} - \frac{I}{A}\right]$$

and superimposing over the plot on Page 654, the common solution for $\frac{a}{\Delta}$ and $\frac{\Delta}{L}$ can be found at the intersection of the two plots. Since L is always a known quantity, a and Δ can now be computed and will provide the maximum deflections at $\sigma_{max} = F_{cy}$. Of course, the deflections at any other level of stress, σ, can be determined by substituting σ in the above formula.

From the preceding derivation, it was seen that the Euler formula, $P_{cr} = \frac{EI\pi^2}{L^2}$, was but a specific solution ($\Delta = 0$, $L = b$) of the basic formula

$P_L = \frac{EI\pi^2}{b^2} = \frac{EI\pi^2}{(L-\Delta)^2}$ where P_L is established by substituting Δ at $\sigma_{max} = F_{cy}$, or Δ_{max}, in the formula.

The author has found that the $\frac{P}{A}$ stress is relatively quite small in very long columns which are those under discussion. Since the above procedure is somewhat laborious without a computerized solution, a separate derivation has resulted in a supplemental curve assuming $\frac{Mc}{I}$ stress only.

As was previously seen,

$$P_L = \frac{F_{cy}}{\frac{1}{A} + \frac{ac}{I}} = \frac{EI\pi^2}{(L-\Delta)^2}$$

Assuming $\frac{P_L}{A} = 0$ and re-writing,

$$\frac{F_{cy} I}{ac} = \frac{EI\pi^2}{(L-\Delta)^2}$$

Simplifying and again re-writing,

$$\frac{F_{cy}}{Ec} = \frac{a\pi^2}{(L-\Delta)^2} = \frac{a\pi^2}{L^2 - 2\Delta L + \Delta^2}$$

Which can be written -

$$\frac{F_{cy}}{Ec} = \frac{\frac{a\pi^2}{\Delta}}{\frac{L^2}{\Delta} - 2L + \Delta}$$

Multiplying by L

$$\frac{F_{cy} L}{Ec} = \frac{\frac{a\pi^2}{\Delta}}{\frac{L}{\Delta} - 2 + \frac{\Delta}{L}}$$

(Note that $\frac{F_{cy} L}{Ec}$ is non-dimensionless)

By assuming values of Δ, a can be determined from the first curve of $\frac{a}{\Delta}$ versus $\frac{\Delta}{L}$ and $\frac{F_{cy} L}{Ec}$ can be plotted versus $\frac{\Delta}{L}$ to generate the second curve. The second curve is quiet useful in determining Δ quickly from any given value of stress since the column parameters will be known. The column load at that stress can then be determined from $P = \frac{EI\pi^2}{(L-\Delta)^2}$

Examination of the $\frac{a}{\Delta}$ versus $\frac{\Delta}{L}$ line reveals that the line is straight up to $\frac{\Delta}{L} \approx .3$. Within this parameter, the equation for this line is

$$\frac{a}{\Delta} \left(\frac{\Delta}{L}\right)^{.52} = .59$$

or $a = .59\ L^{.52}\ \Delta^{.48}$

Example:

Let $L = 10$ in. and $\Delta = .2$ in.

Then $\frac{\Delta}{L} = .02$

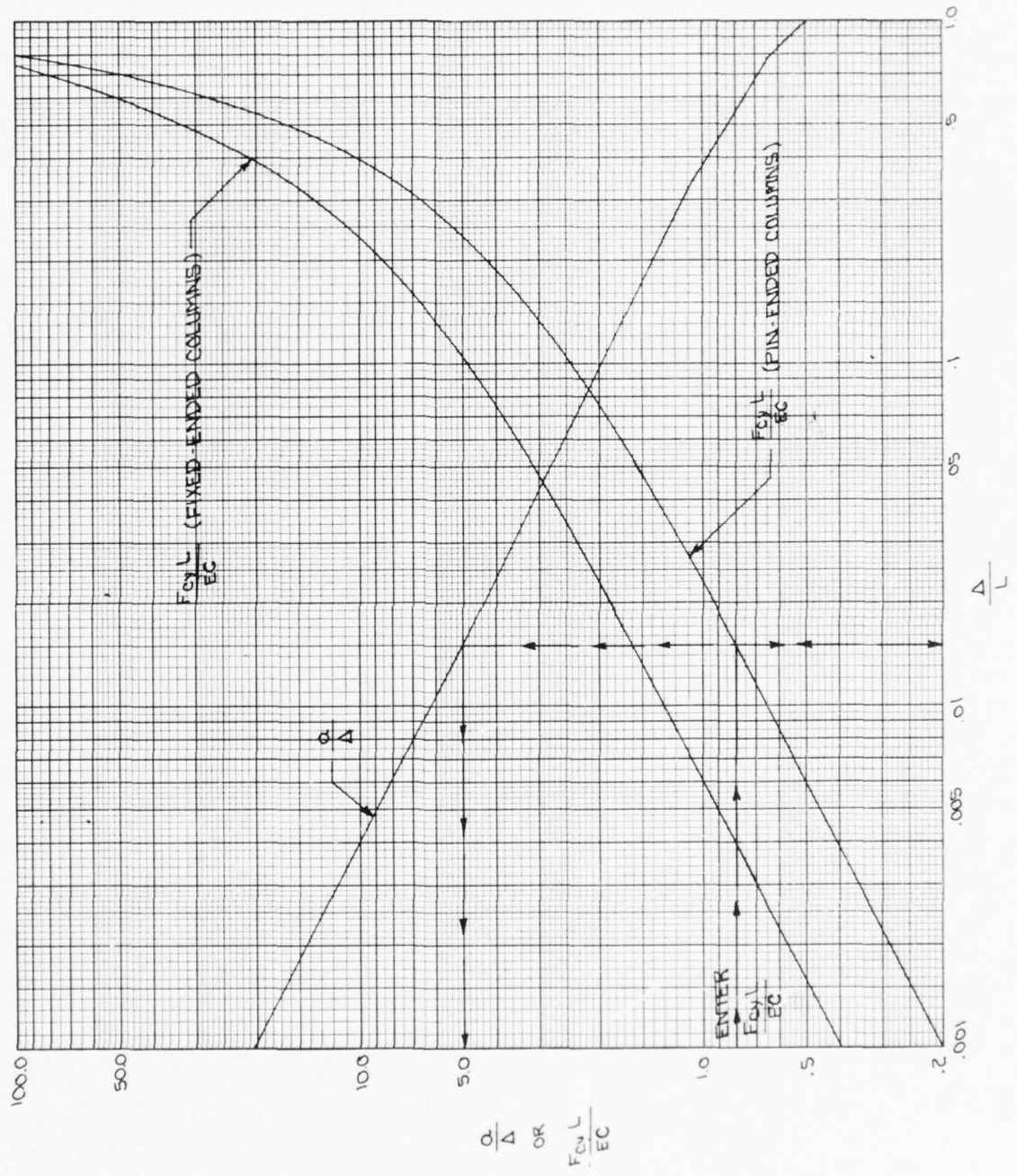
Reading from the curve, $\frac{a}{\Delta} = 4.5$

or $a = .2\ (4.5) = .9$

From the formula -

$$a = .59\ (10)^{.52}\ (.2)^{.48} = .902 \approx .9$$

Similarily, it is noted that the $\frac{F_{cy}L}{Ec}$ line is approximately straight up to $\frac{\Delta}{L} \approx .03$; however, most buckling probrems will warrant examination beyond $\Delta = 3\%$ of L. Therefore, the equation of this line is not presented.



LATERAL VS VERTICAL DEFLECTION
BUCKLED COLUMN DEFLECTION AS A FUNCTION OF COLUMN PROPERTIES

TABLE XLIII

STATIC TEST STRESSES - SPECIMEN NOS. 14 THRU 17
(STRESSES GIVEN IN PSI)

STRAIN GAUGE	LOAD (POUNDS)						
	38.5	44.0	46.8	49.5	52.3	55.0	58.0
S14-1	1411.	2421.	3533.	6159.	14369.	28335.	42735.
S14-2	-1761.	-2843.	-4017.	-6695.	-14750.	-28521.	-42436.
S15-1	3811.	4841.	5737.	7468.	13802.	40479.	-----
S15-2	-4635.	-5603.	-6520.	-8127.	-14286.	-40469.	-----
S16-1	1391.	2276.	3069.	3873.	20147.	34814.	41365.
S16-2	-2194.	-3193.	-4089.	-4893.	-20755.	-35123.	-41458.
S17-1	1442.	3162.	5541.	11165.	31590.	42055.	-----
S17-2	-2256.	-4038.	-6283.	-11649.	-32157.	-42436.	-----

TABLE XLIV

STATIC TEST DISPLACEMENTS - SPECIMEN NOS. 14 THRU 17
(VERTICAL DISPLACEMENT IS DISPLACEMENT OF PISTON PARALLEL TO COLUMN AXIS, AND LATERAL DISPLACEMENT IS MEASURED PERPENDICULAR TO COLUMN AT ITS CENTER.)

	LOAD (POUNDS)						
	38.5	44.0	46.8	49.5	52.3	55.0	58.0
NO. 14 LATERAL DISPLACEMENT (IN.)	.08	.10	.13	.21	.45	.85	1.24
NO. 14 VERTICAL DISPLACEMENT (IN.)	.01	.02	.02	.03	.06	.18	.39
NO. 15 LATERAL DISPLACEMENT (IN.)	.09	.13	.16	.22	.42	1.20	----
NO. 15 VERTICAL DISPLACEMENT (IN.)	0	0	0	.01	.03	.36	----
NO. 16 LATERAL DISPLACEMENT (IN.)	.04	.06	.09	.11	.61	1.04	1.23
NO. 16 VERTICAL DISPLACEMENT (IN.)	0	.01	.01	.03	.09	.27	.38
NO. 17 LATERAL DISPLACEMENT (IN.)	.07	.14	.21	.33	.94	1.22	----
NO. 17 VERTICAL DISPLACEMENT (IN.)	0	0	.01	.03	.22	.40	----

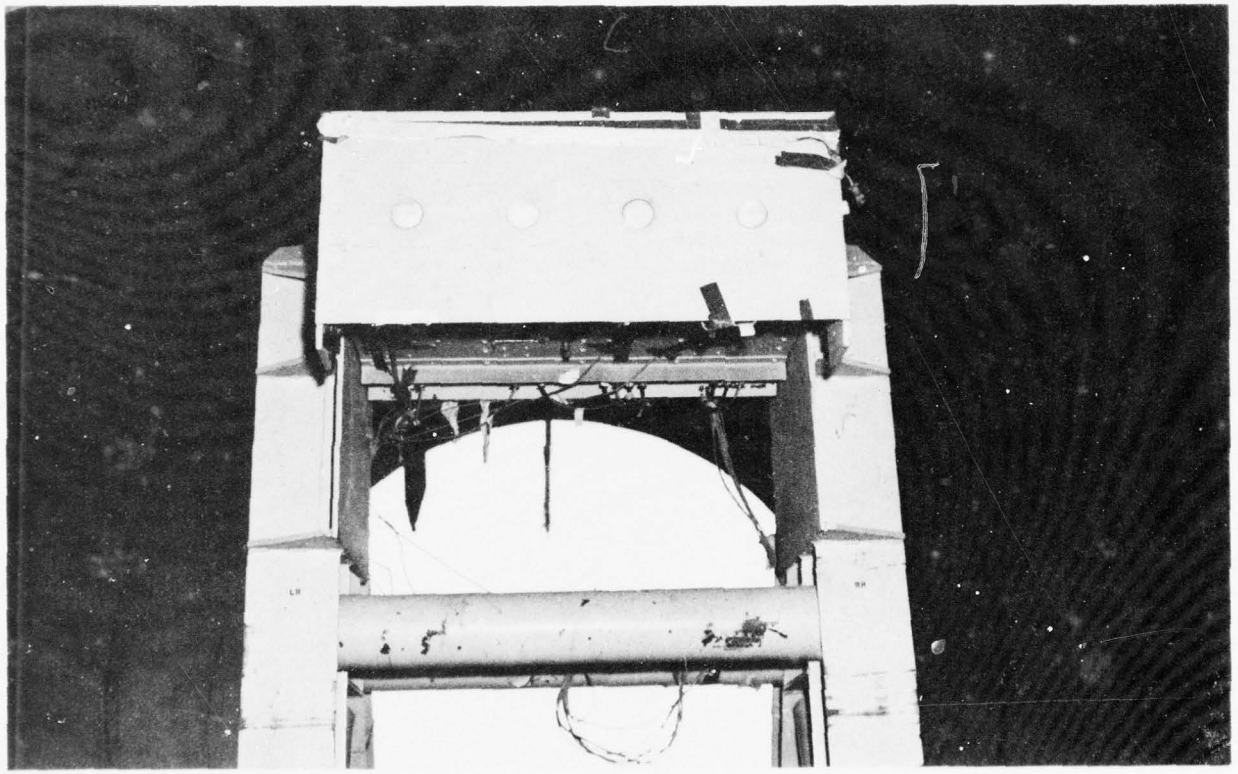


FIGURE 14-5 - SPECIMEN NOS. 14 THRU 17 - SHOCK TEST SET-UP - FRONT VIEW

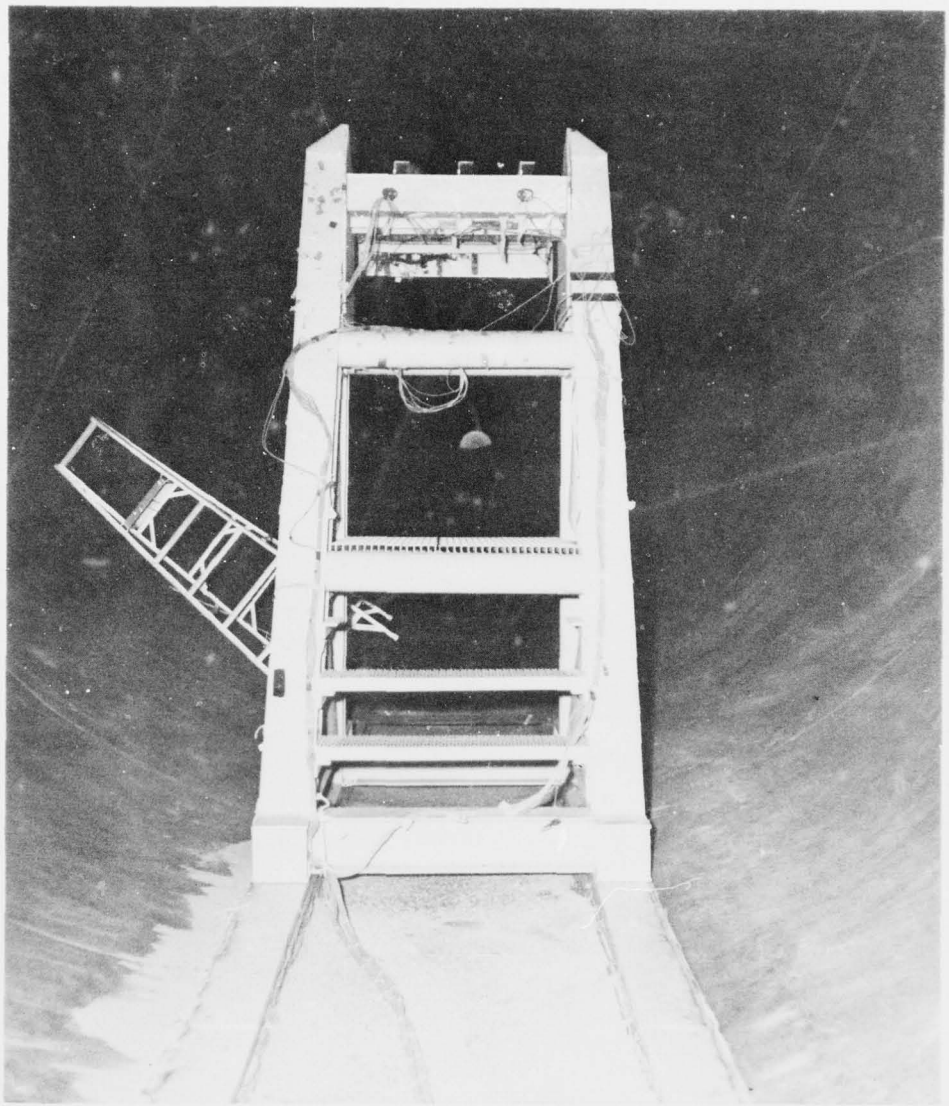


FIGURE 14-6 - SPECIMEN NOS. 14 THRU 17 - SHOCK TEST SET-UP - REAR VIEW

NOVA-2 DATA DECK LISTING

```
TEST SPECIMEN NO.14-17-DYNAMIC ANALYSIS - ITERATIVE SOLUTION - MAY'76 RPS  GP  1
          1           0                                                    GP  2
5000.      0.001       0.02       0.0                                      GP  3
0.0        0.0         0.0        0.0                                      GP  4
         15          15                                                    GP  5
132.7                                                                      GP  7
                                                                           GP  8
          2           0                                                    GP  9
          0           1                                                    GP 10
.50                                                                        GP 11
          0           0                                                    GP 12
          0           0                                                    GP 15
          2           2                                                    GP 18
48.0       0.0                                                             GP 19
20.0      96.0                                                             GP 19
-60.0      0.0                                                             GP 20
-70.0     96.0                                                             GP 20
          0                                                                GP 21
          4          10           1                                       GP 25
-21.0      0.0        21.0                                                 GP 26
          2           2           2           1           1                GPB  1
         19           1           6                                        GPB  2
0.0        0.0                                                             GPB  5
0.0        0.5                                                             GPB  5
0.0        1.0                                                             GPB  6
0.0        1.5                                                             GPB  6
0.0        2.0                                                             GPB  6
0.0        2.5                                                             GPB  6
0.0        3.0                                                             GPB  5
0.0        3.5                                                             GPB  6
0.0        4.0                                                             GPB  6
0.0        4.5                                                             GPB  6
0.0        5.0                                                             GPB  6
0.0        5.5                                                             GPB  6
0.0        6.0                                                             GPB  6
0.0        6.5                                                             GPB  6
0.0        7.0                                                             GPB  6
0.0        7.5                                                             GPB  6
0.0        8.0                                                             GPB  6
0.0        8.5                                                             GPB  6
0.0        9.0                                                             GPB  6
0.0        9.5                                                             GPB  6
0.0       10.0                                                             GPB  7
          0                                                                GPB  8
          0                                                                GPB 12
0.000262                                                                   GPB 13
0.9618                                                                     GPB 14
0.031                                                                      GPB 15
5.0                                                                        GPB 16
          3                                                                GPB 17
0.006714  70500.                                                           GPB 18
0.02      78000.                                                           GPB 18
0.08      83000.                                                           GPB 18
0.03                                                                       GPB 21
0.0       0.020      50.0                                                  GPB 22
                                                                           GPB 32
```

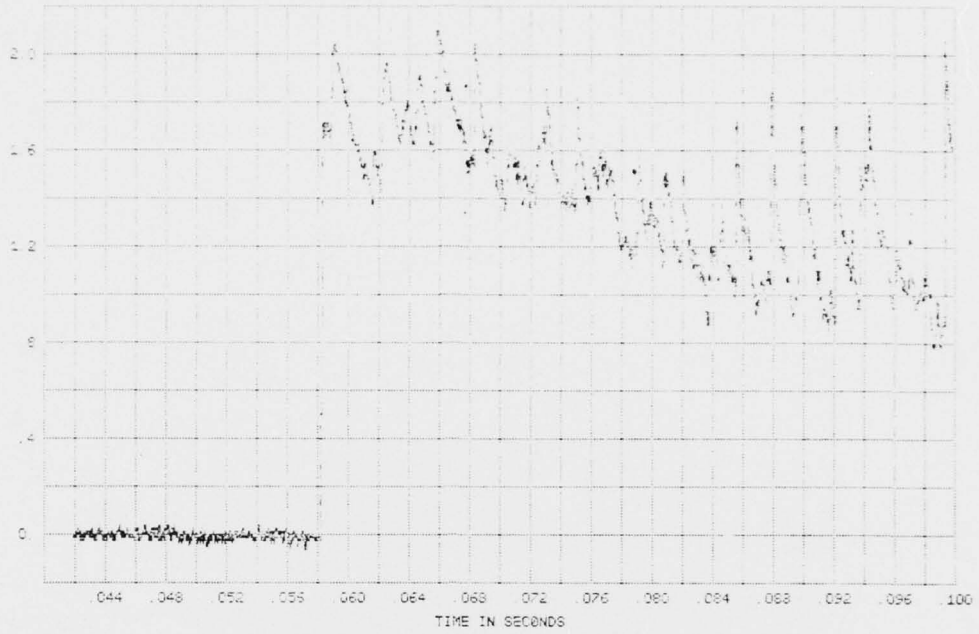


FIGURE 14-7 , SPECIMEN NO. 14-17 , SHOT NO. 1 .
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

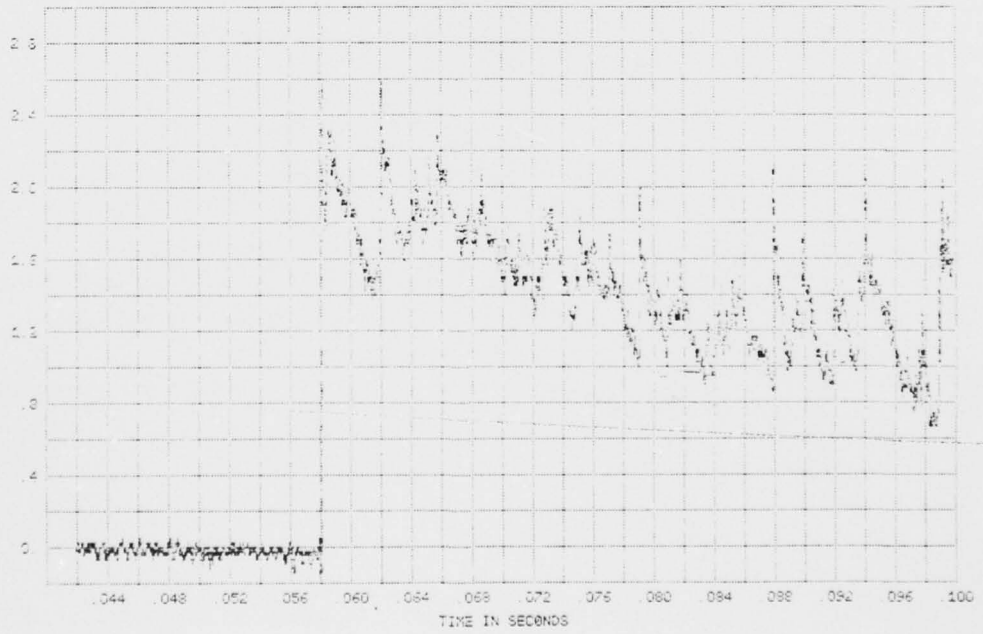


FIGURE 14-8 , SPECIMEN NO. 14-17 , SHOT NO. 1
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

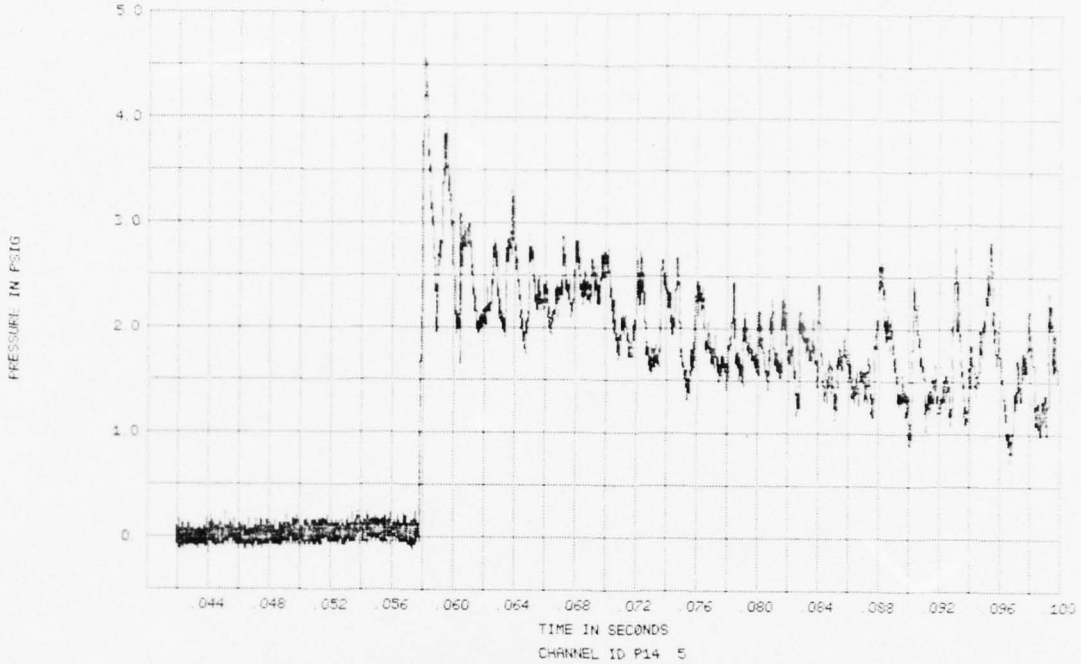


FIGURE 14-9 , SPECIMEN NO. 14 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

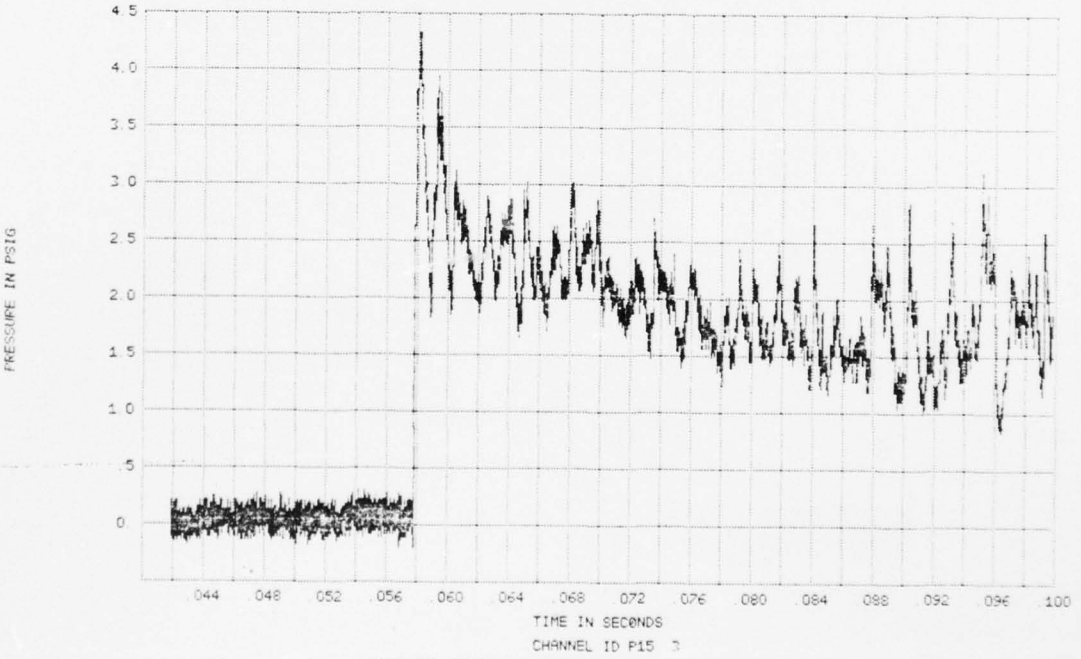


FIGURE 14-10 , SPECIMEN NO. 15 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

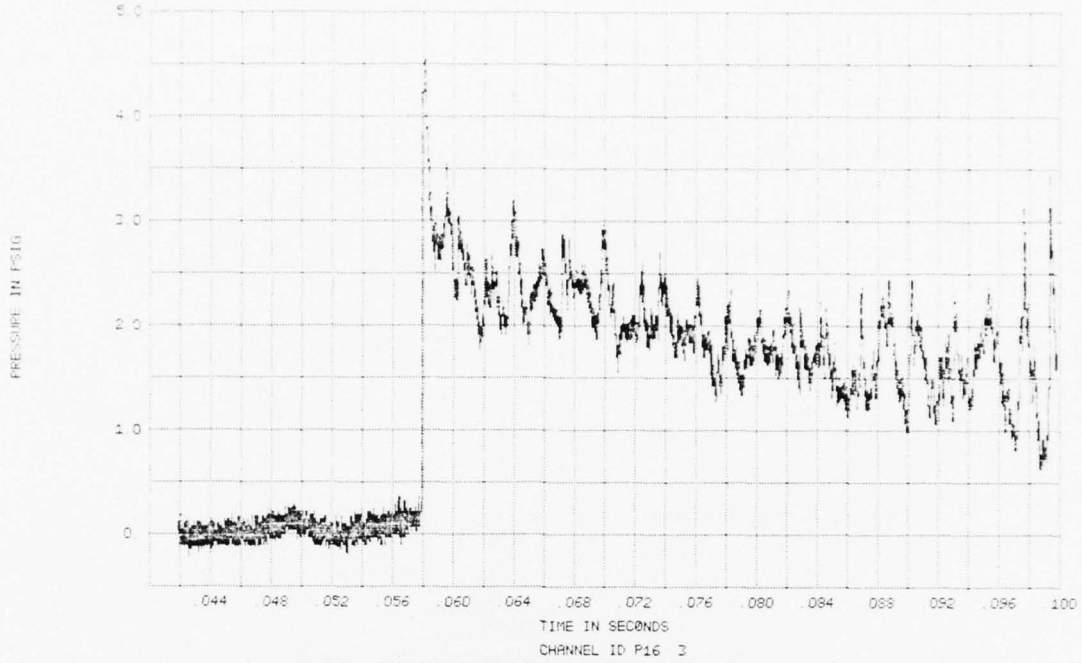


FIGURE 14-11 , SPECIMEN NO. 16 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

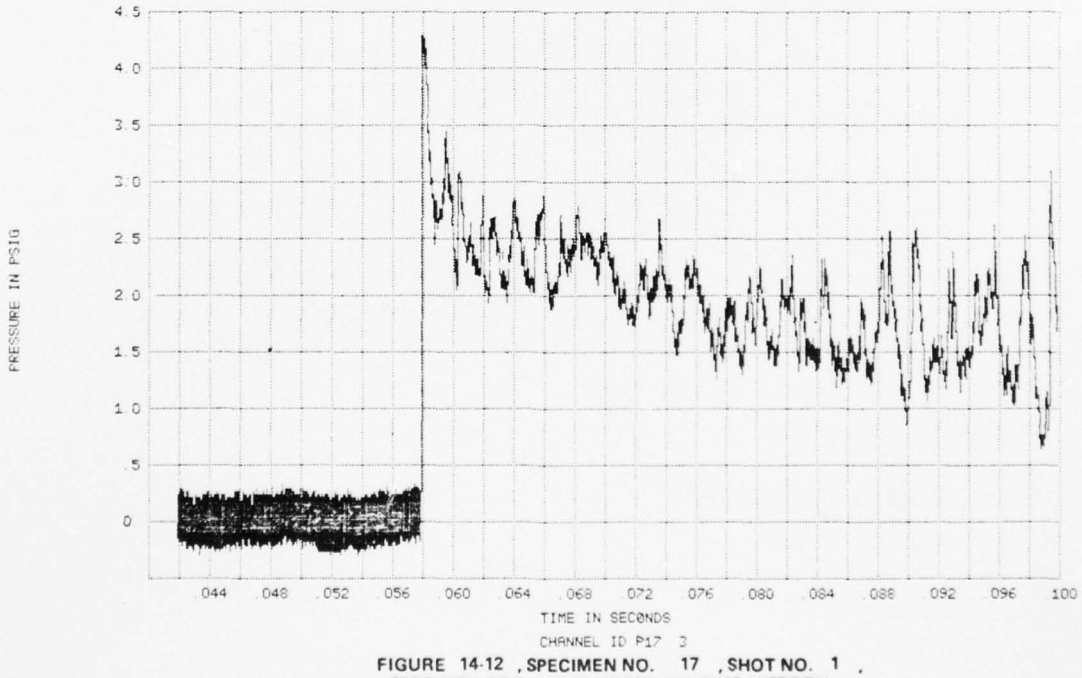


FIGURE 14-12 , SPECIMEN NO. 17 , SHOT NO. 1 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

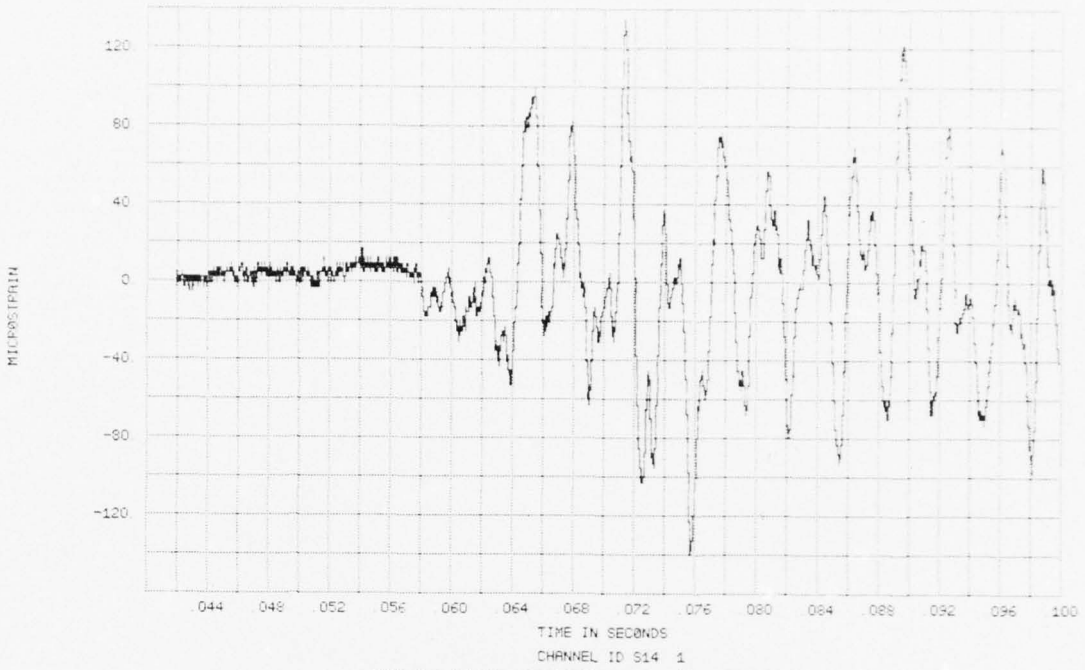


FIGURE 14-13 , SPECIMEN NO. 14 , SHOT NO. 1 ,
STRAIN TIME HISTORY

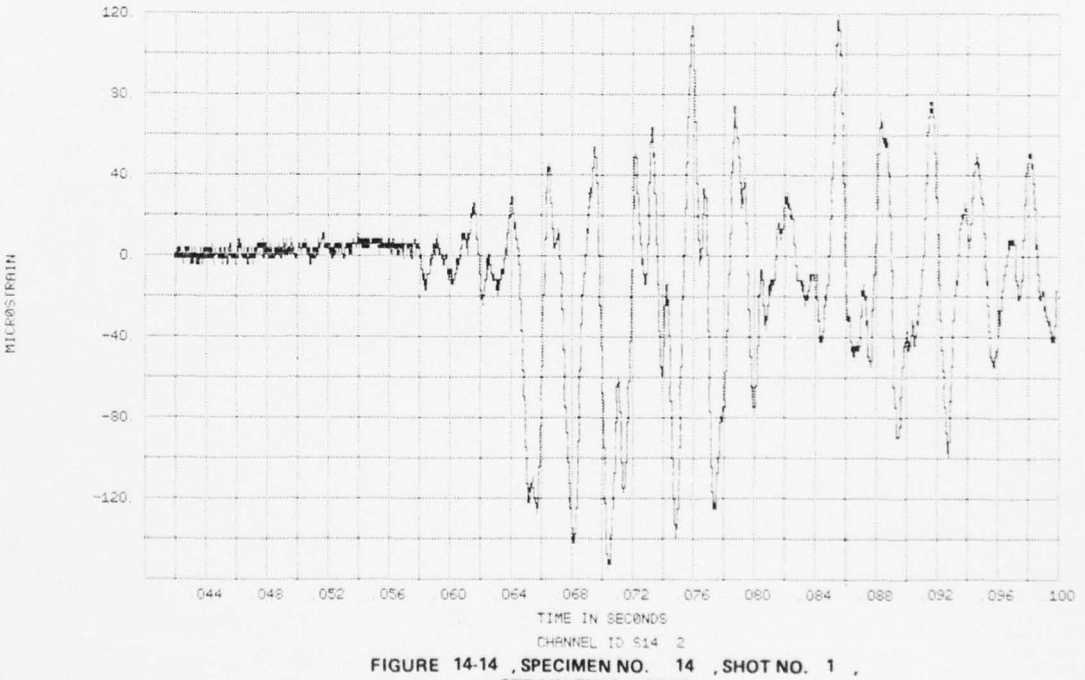


FIGURE 14-14 , SPECIMEN NO. 14 , SHOT NO. 1 ,
STRAIN TIME HISTORY

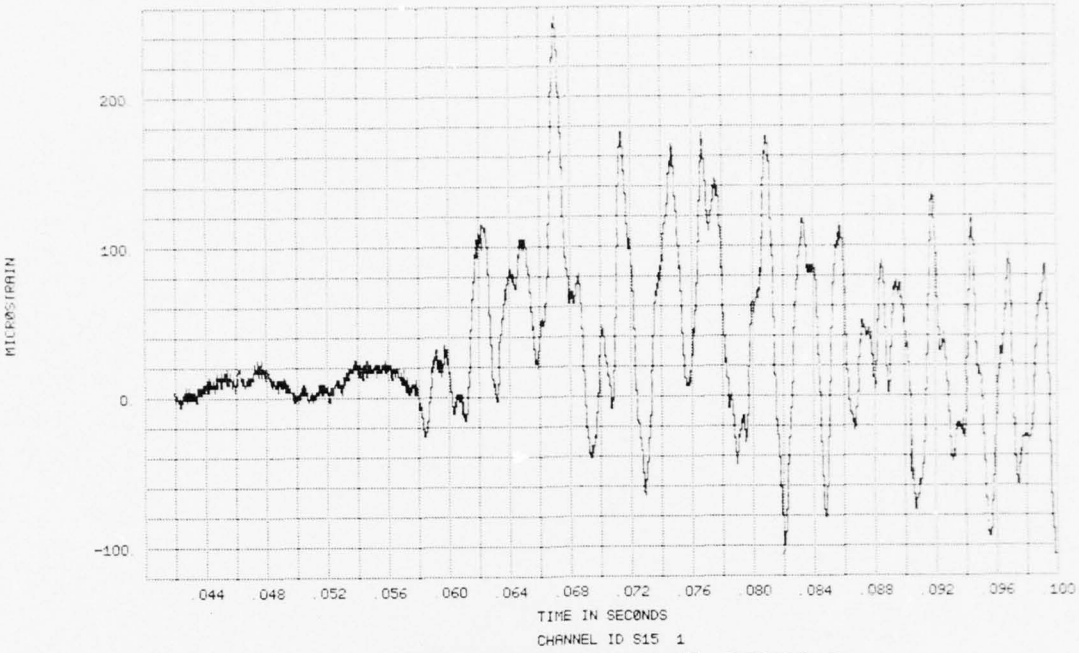


FIGURE 14-15 , SPECIMEN NO. 15 , SHOT NO. 1 , STRAIN TIME HISTORY

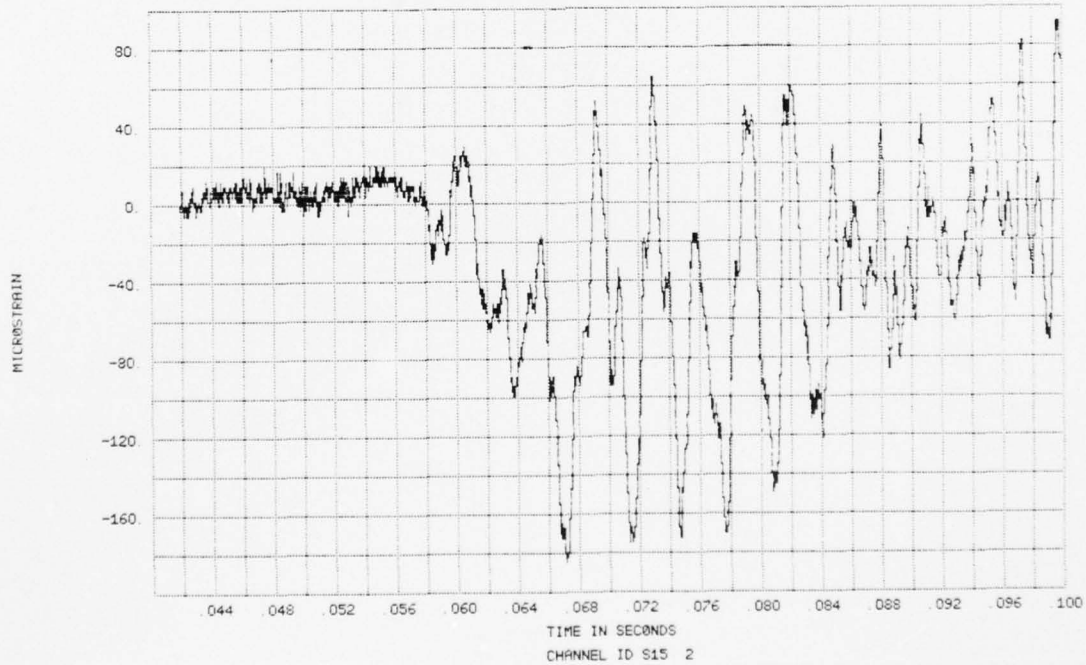


FIGURE 14-16 , SPECIMEN NO. 15 , SHOT NO. 1 , STRAIN TIME HISTORY

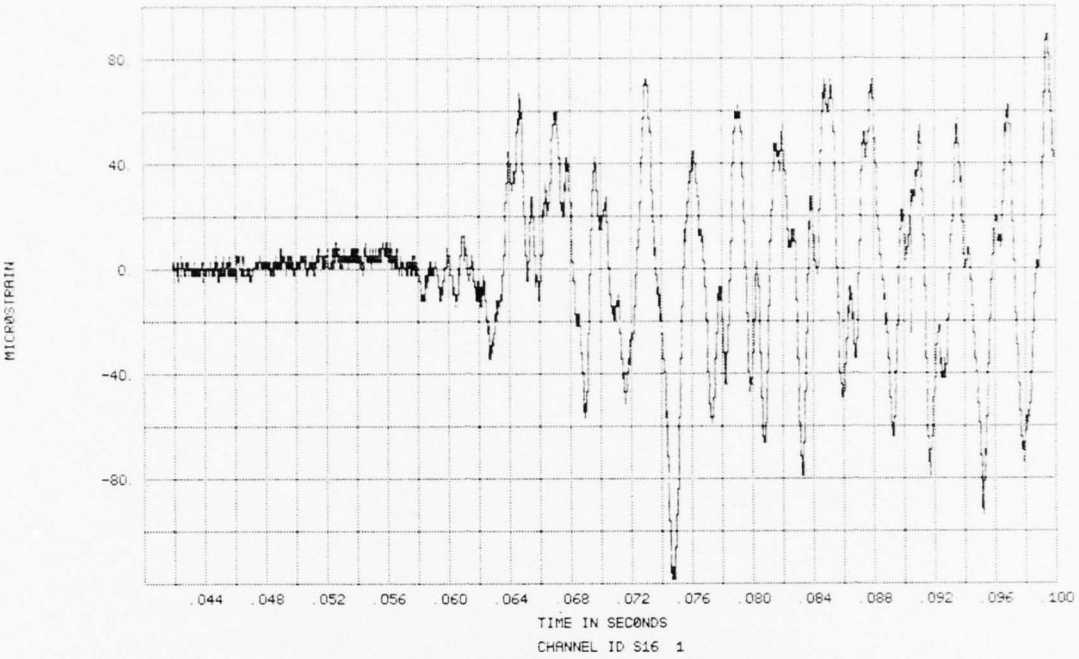


FIGURE 14-17 , SPECIMEN NO. 16 , SHOT NO. 1 , STRAIN TIME HISTORY

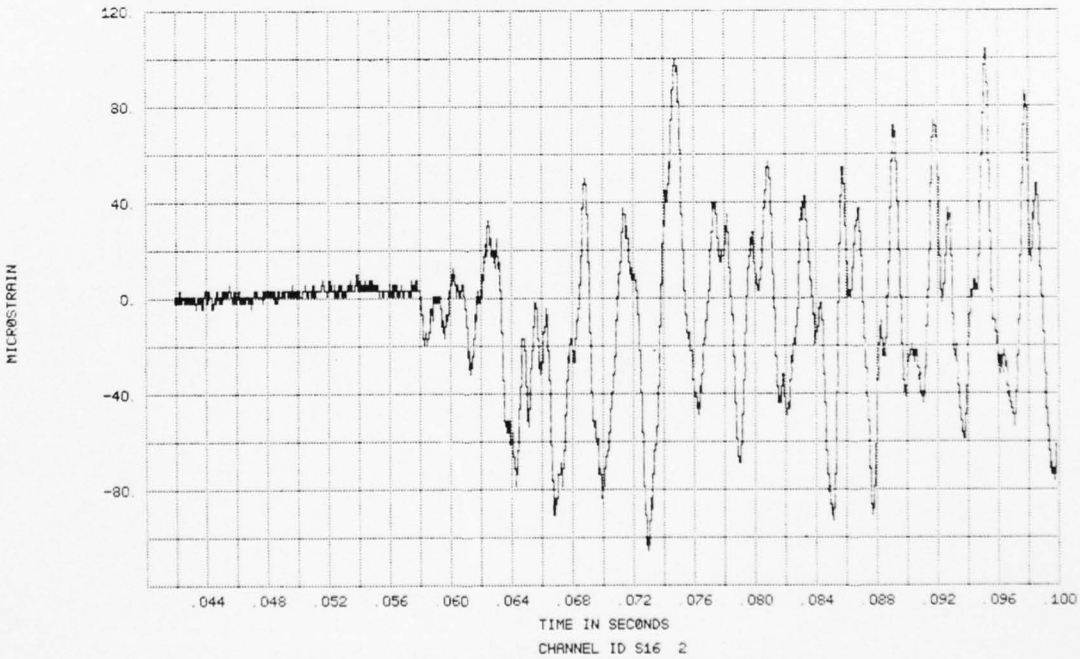


FIGURE 14-18 , SPECIMEN NO. 16 , SHOT NO. 1 , STRAIN TIME HISTORY

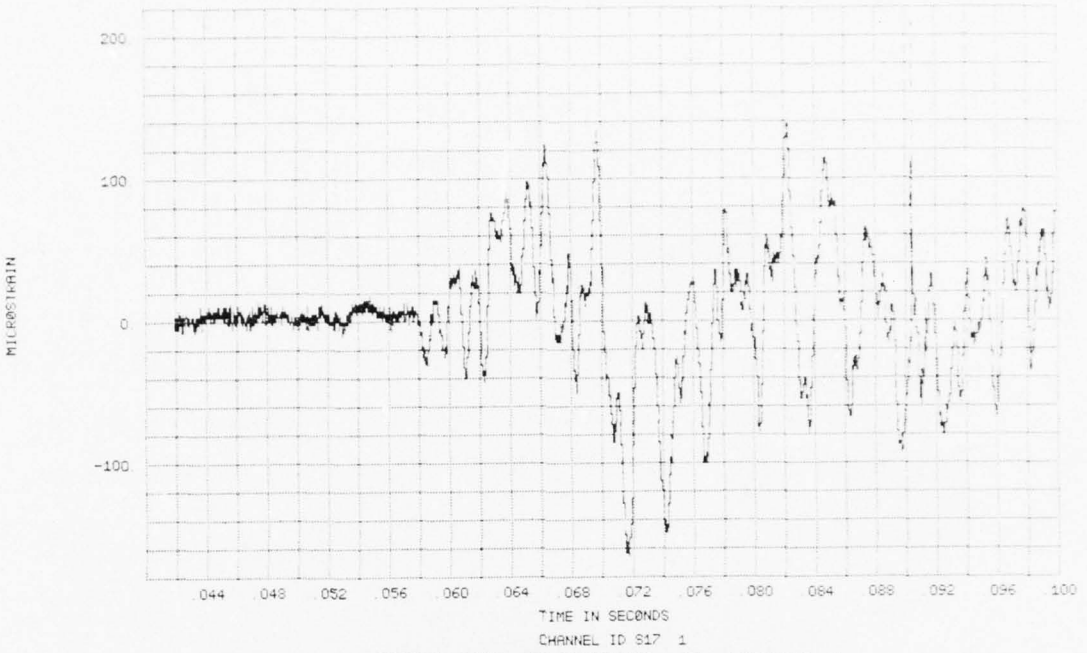


FIGURE 14-19 , SPECIMEN NO. 17 , SHOT NO. 1 , STRAIN TIME HISTORY

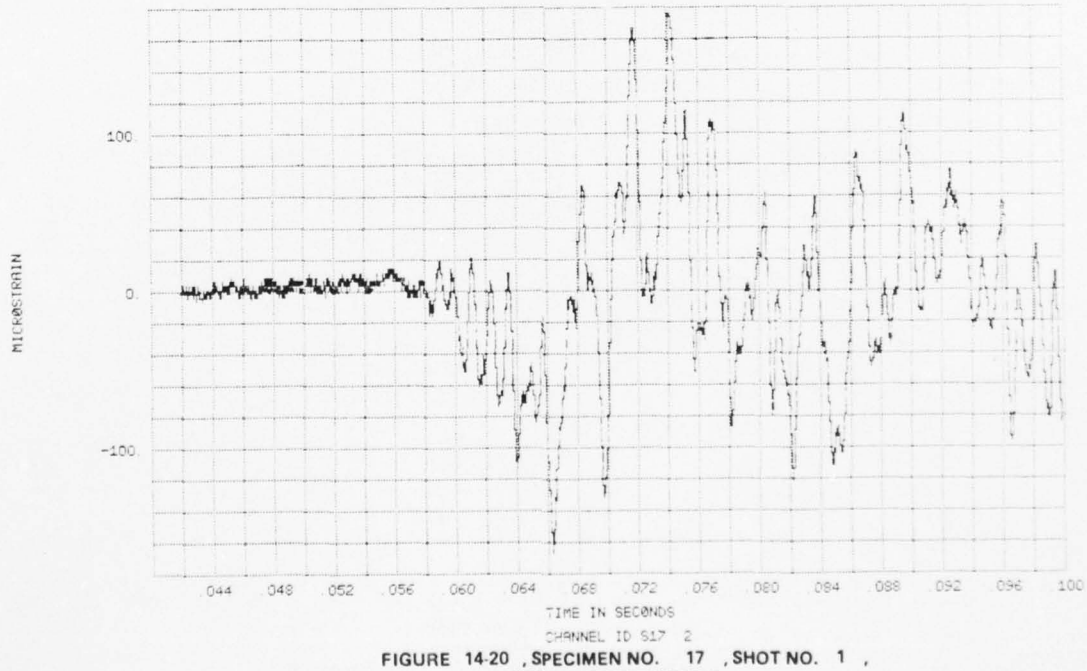


FIGURE 14-20 , SPECIMEN NO. 17 , SHOT NO. 1 , STRAIN TIME HISTORY

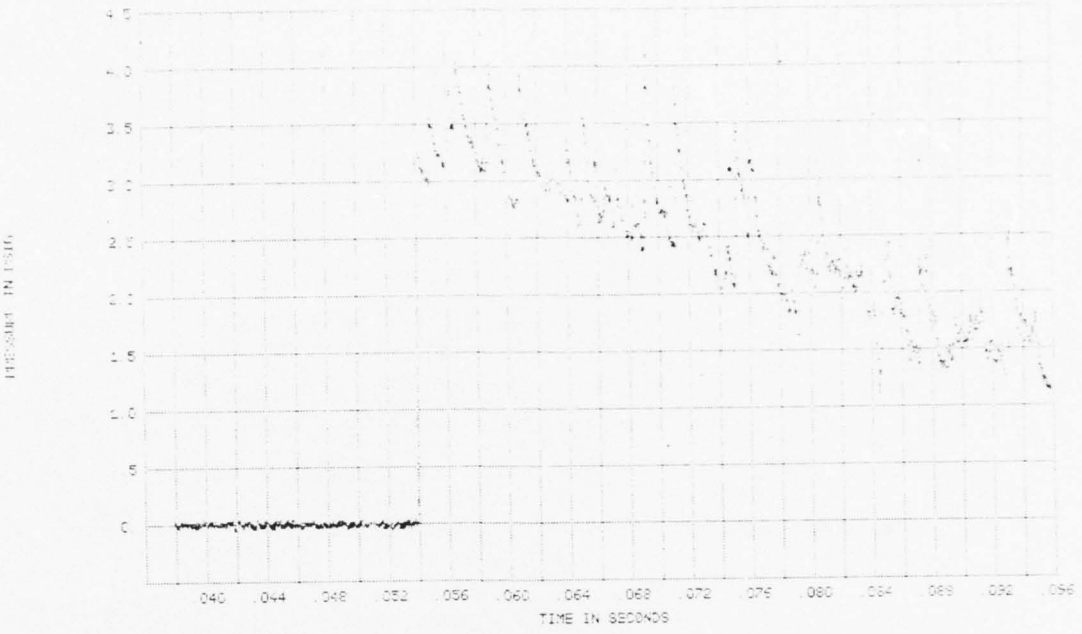


FIGURE 14-21 , SPECIMEN NO. 14-17 , SHOT NO. 2 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

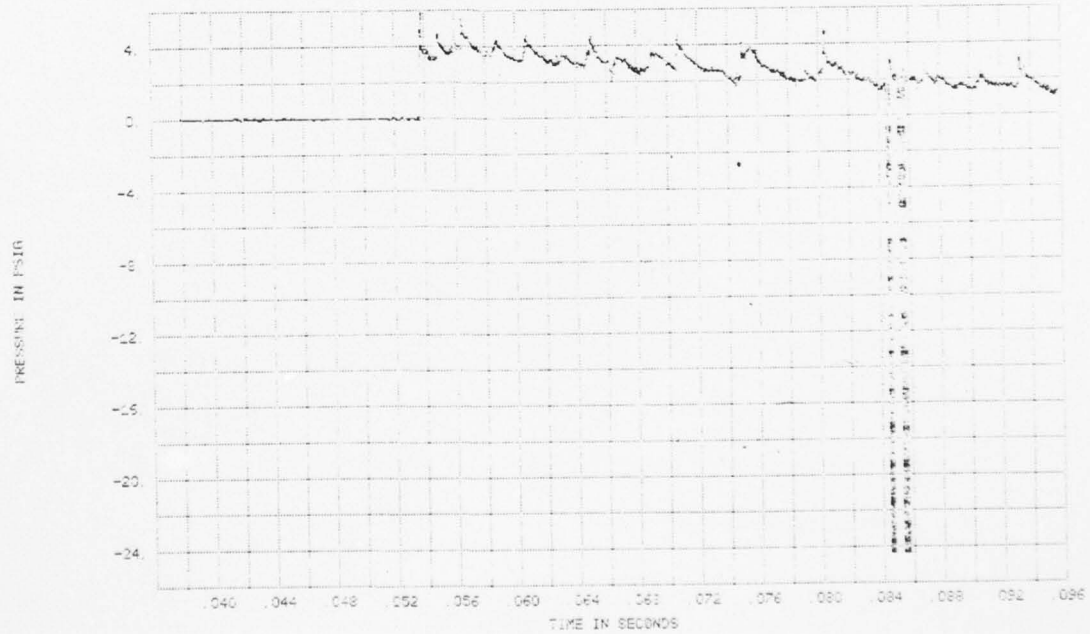


FIGURE 14-22 , SPECIMEN NO. 14-17 , SHOT NO. 2 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

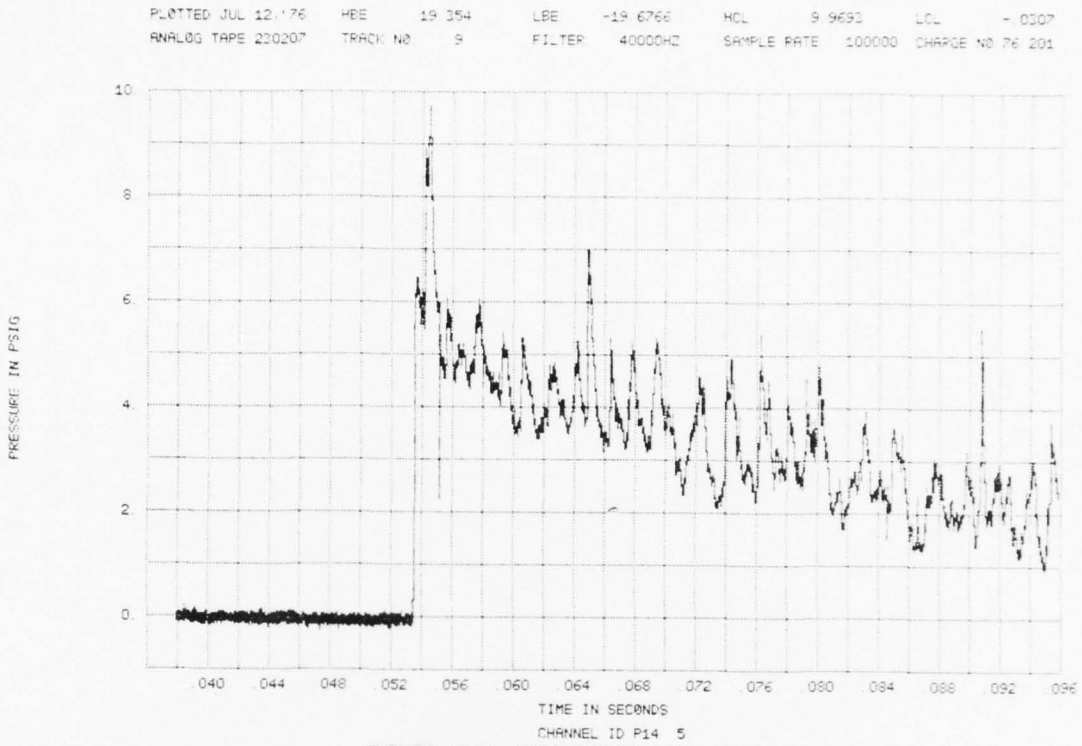


FIGURE 14-23 , SPECIMEN NO. 14 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

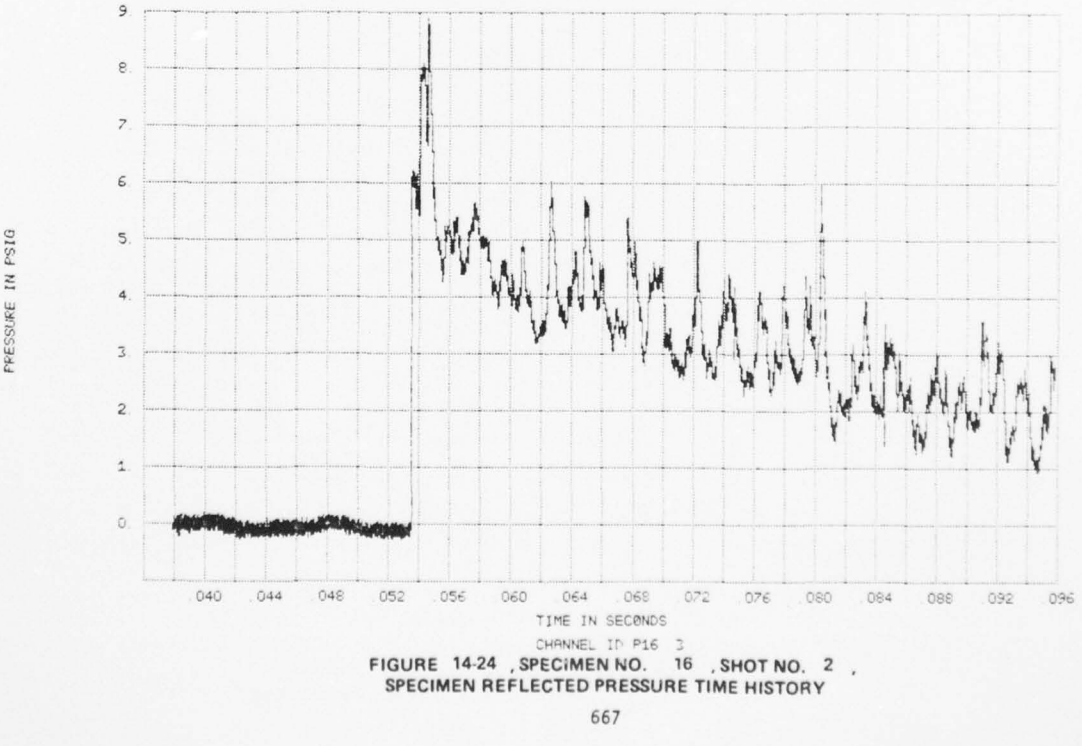


FIGURE 14-24 , SPECIMEN NO. 16 , SHOT NO. 2 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

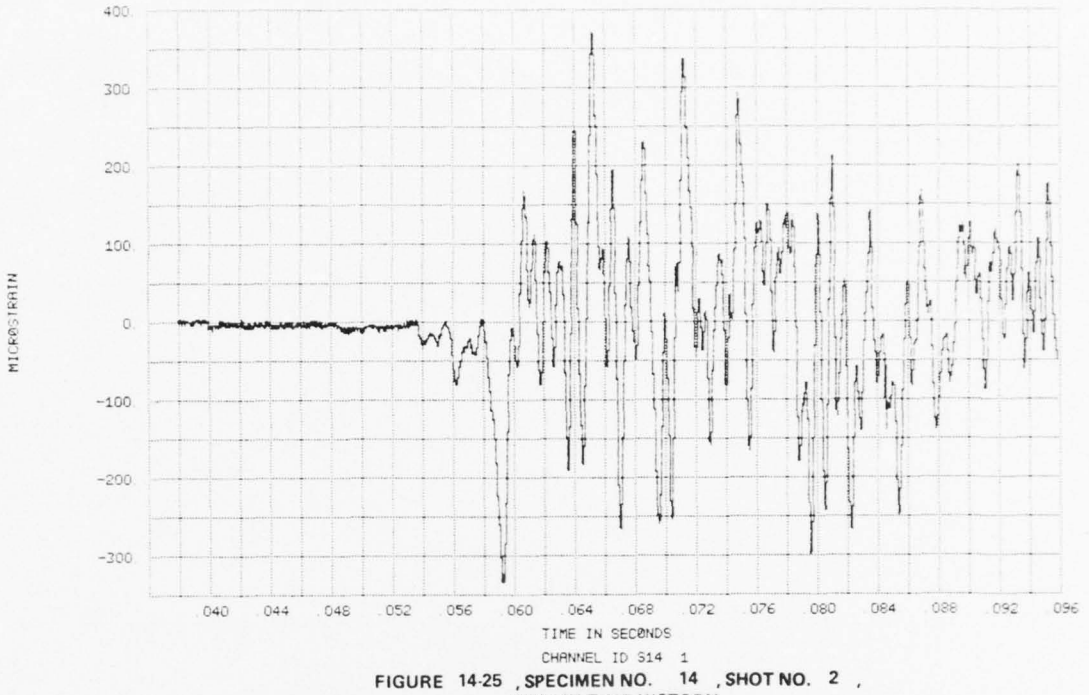


FIGURE 14-25 , SPECIMEN NO. 14 , SHOT NO. 2 , STRAIN TIME HISTORY

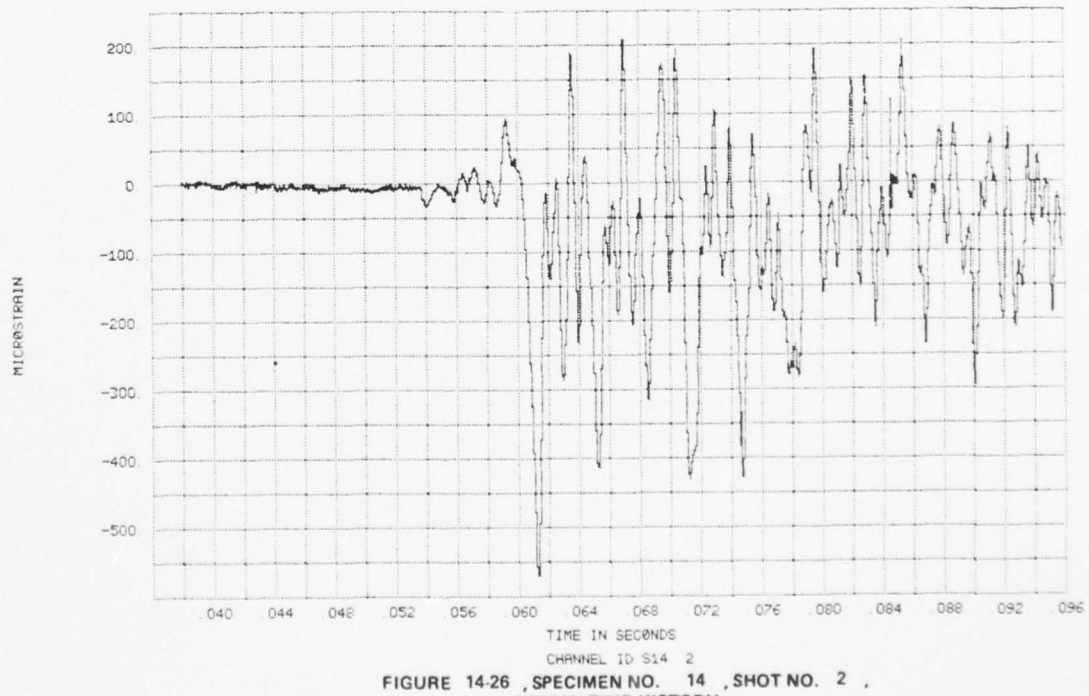


FIGURE 14-26 , SPECIMEN NO. 14 , SHOT NO. 2 , STRAIN TIME HISTORY

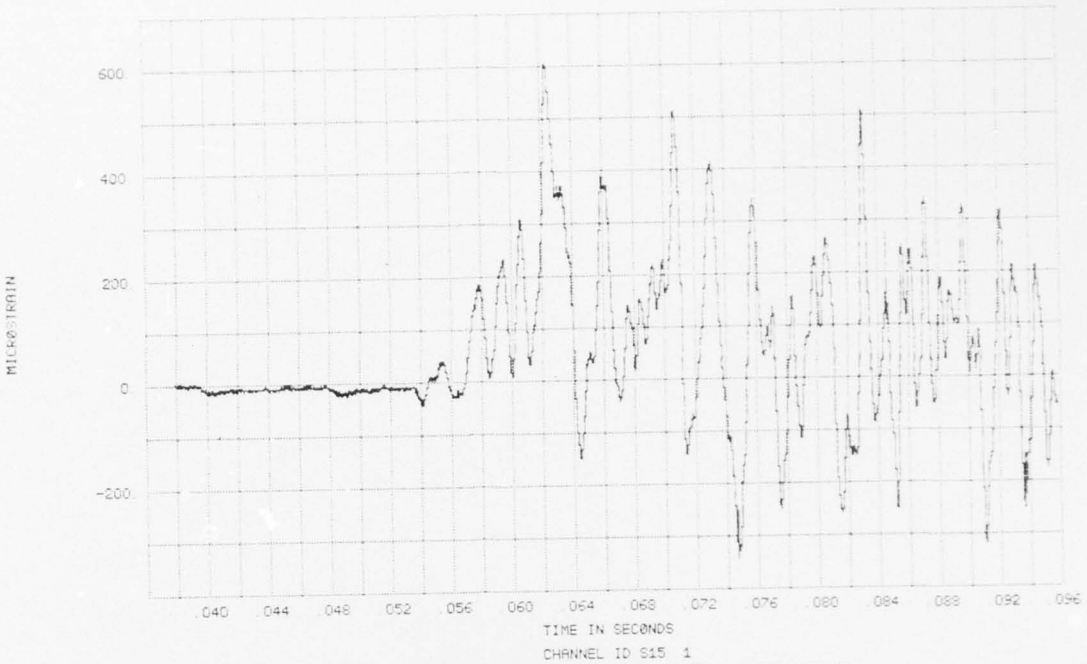


FIGURE 14-27 , SPECIMEN NO. 15 , SHOT NO. 2 ,
STRAIN TIME HISTORY

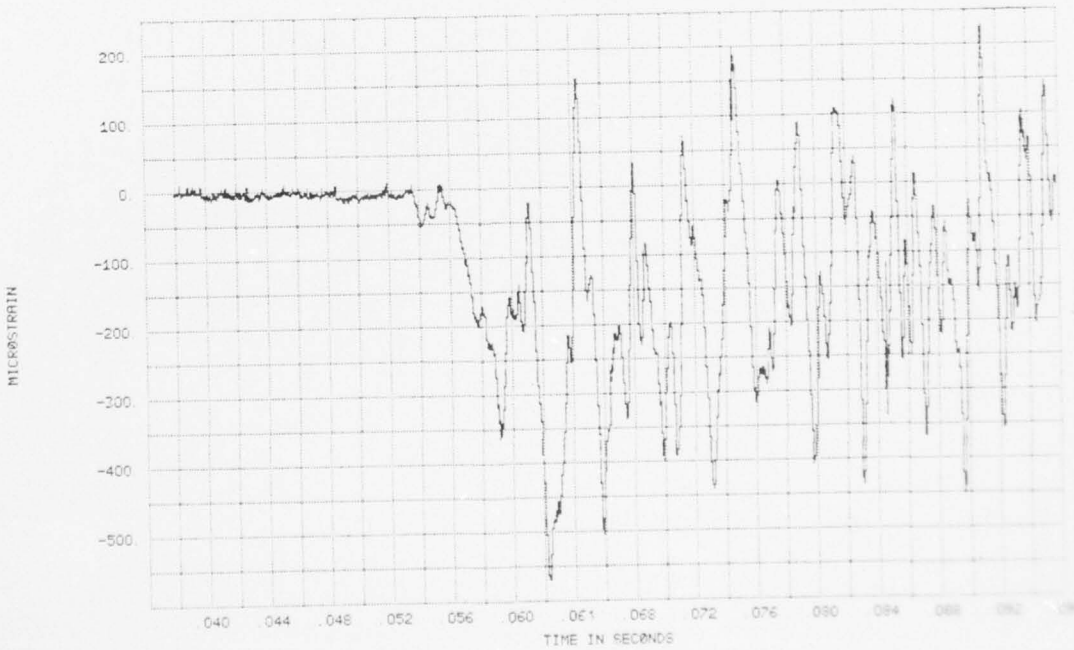
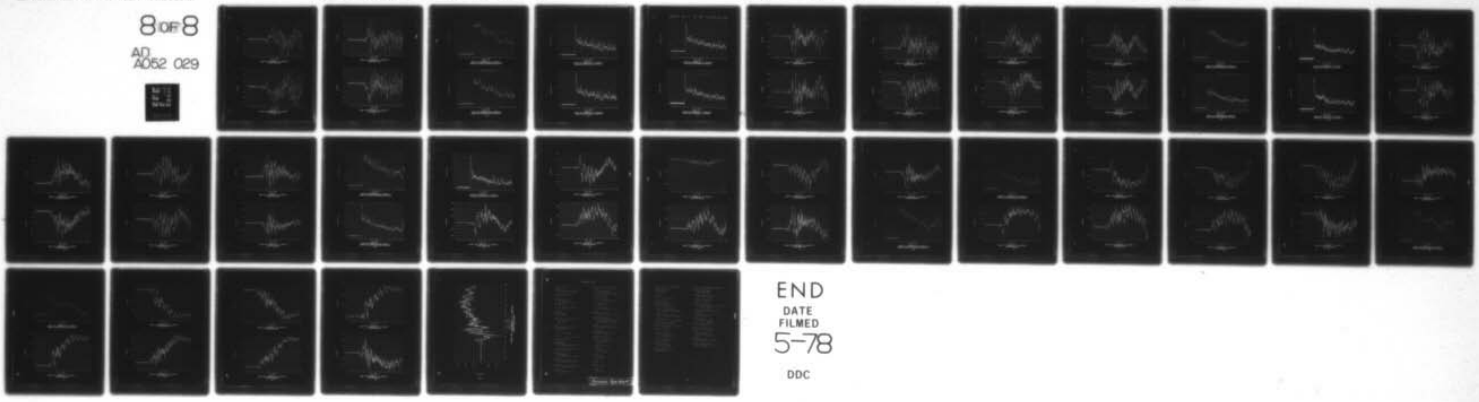


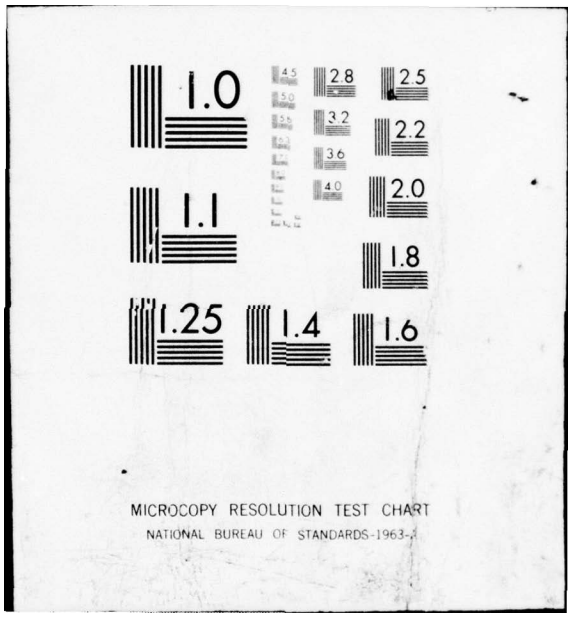
FIGURE 14-28 , SPECIMEN NO. 15 , SHOT NO. 2 ,
STRAIN TIME HISTORY

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STRUCTURAL RESPONSE TO SIMULATED NUCLEAR OVERPRESSURE (STRESNO)--ETC(U)
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UNCLASSIFIED D3-9788-5-VOL-2 DNA-4278F-2 NL

8 OF 8
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NATIONAL BUREAU OF STANDARDS-1963-A

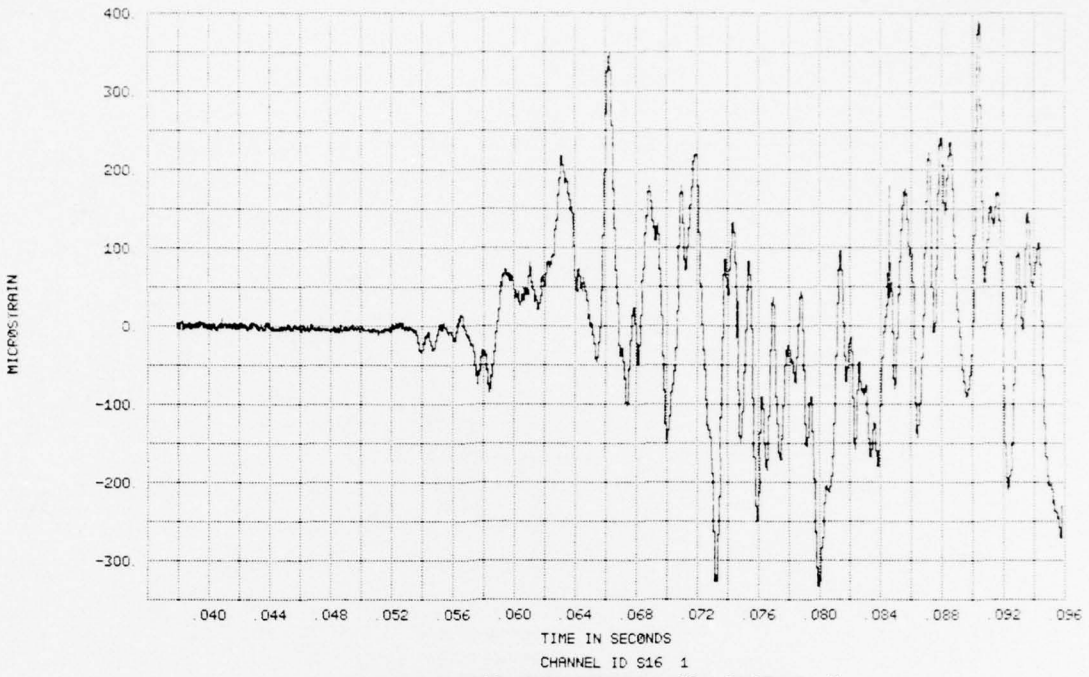


FIGURE 14-29 , SPECIMEN NO. 16 , SHOT NO. 2 , STRAIN TIME HISTORY

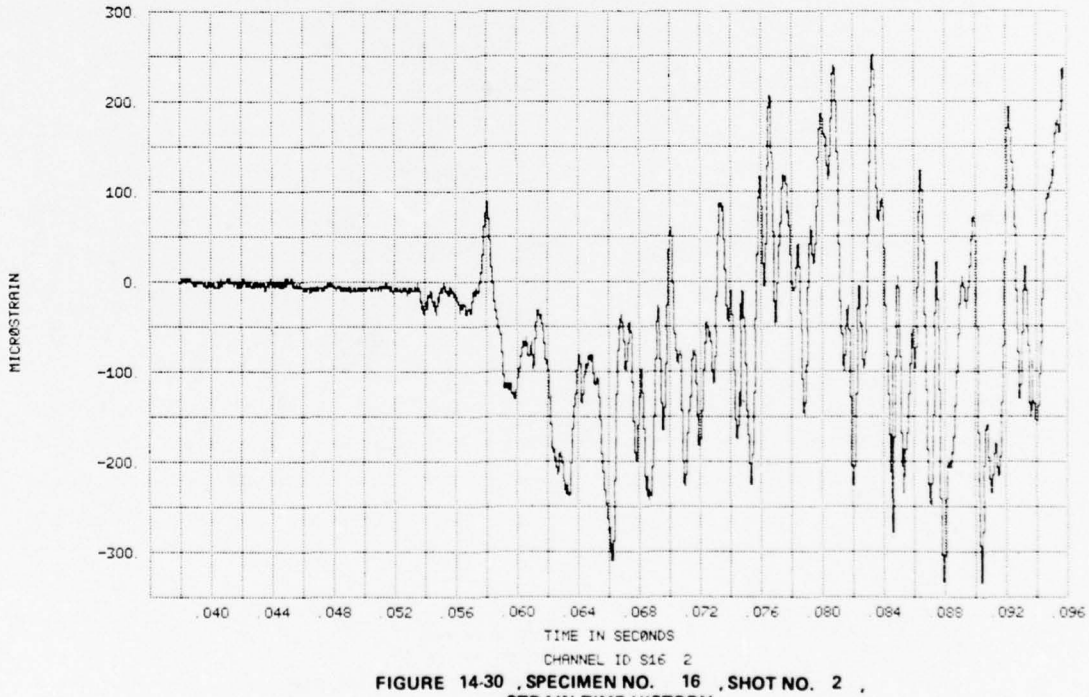


FIGURE 14-30 , SPECIMEN NO. 16 , SHOT NO. 2 , STRAIN TIME HISTORY

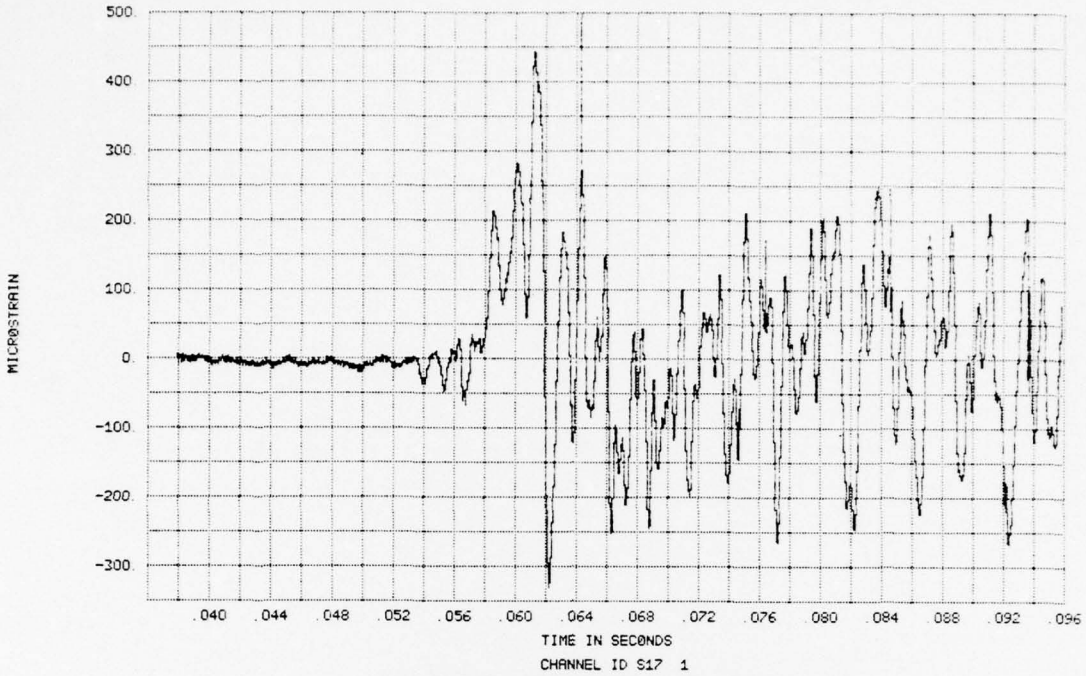


FIGURE 14-31 , SPECIMEN NO. 17 , SHOT NO. 2 ,
STRAIN TIME HISTORY

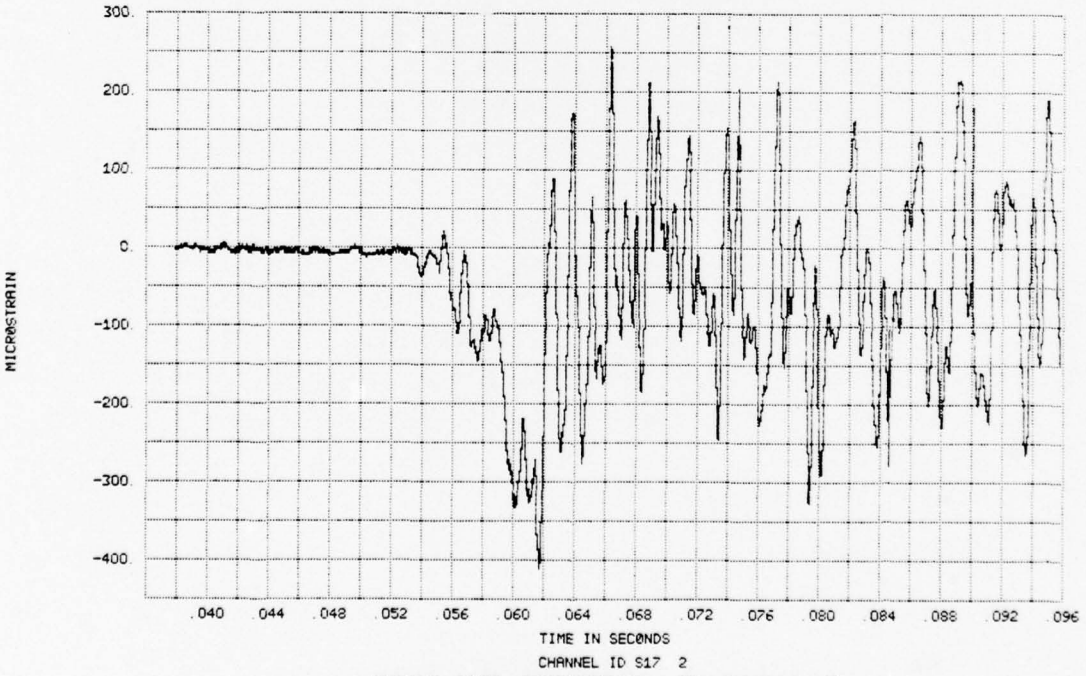


FIGURE 14-32 , SPECIMEN NO. 17 , SHOT NO. 2 ,
STRAIN TIME HISTORY

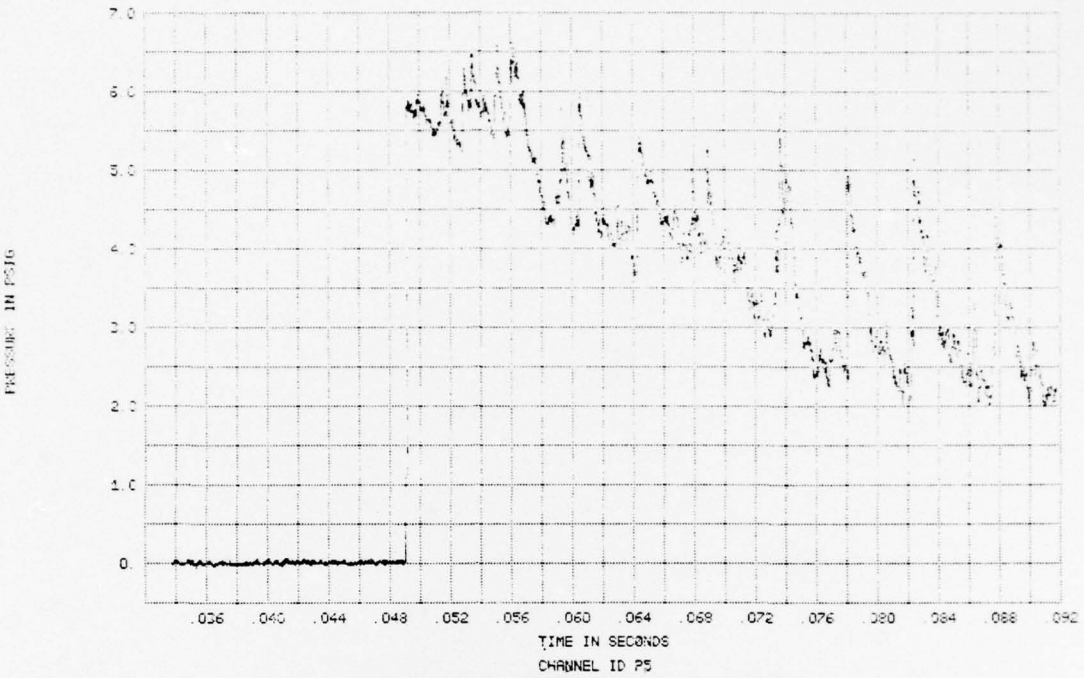


FIGURE 14-33 , SPECIMEN NO. 14-17 , SHOT NO. 3 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

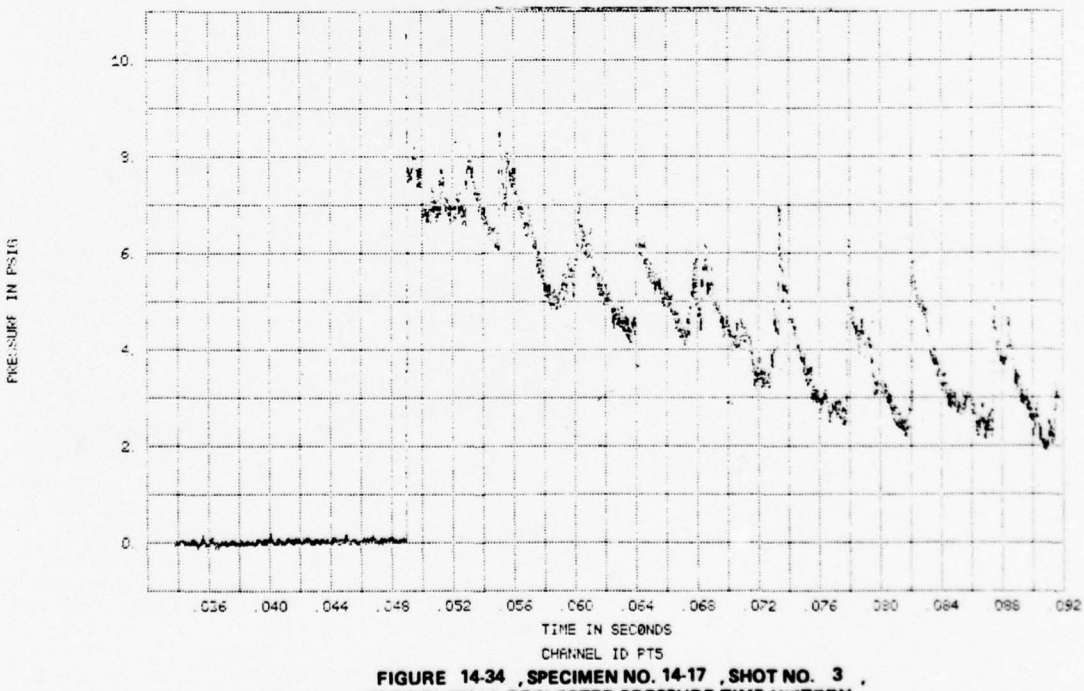


FIGURE 14-34 , SPECIMEN NO. 14-17 , SHOT NO. 3 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

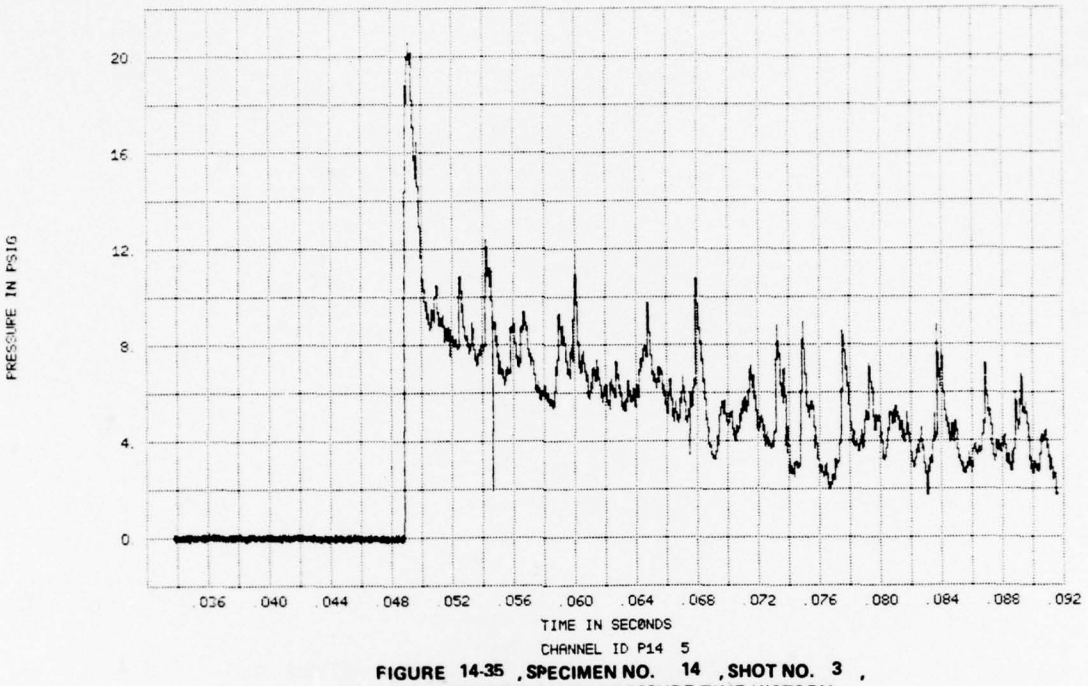


FIGURE 14-35 , SPECIMEN NO. 14 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

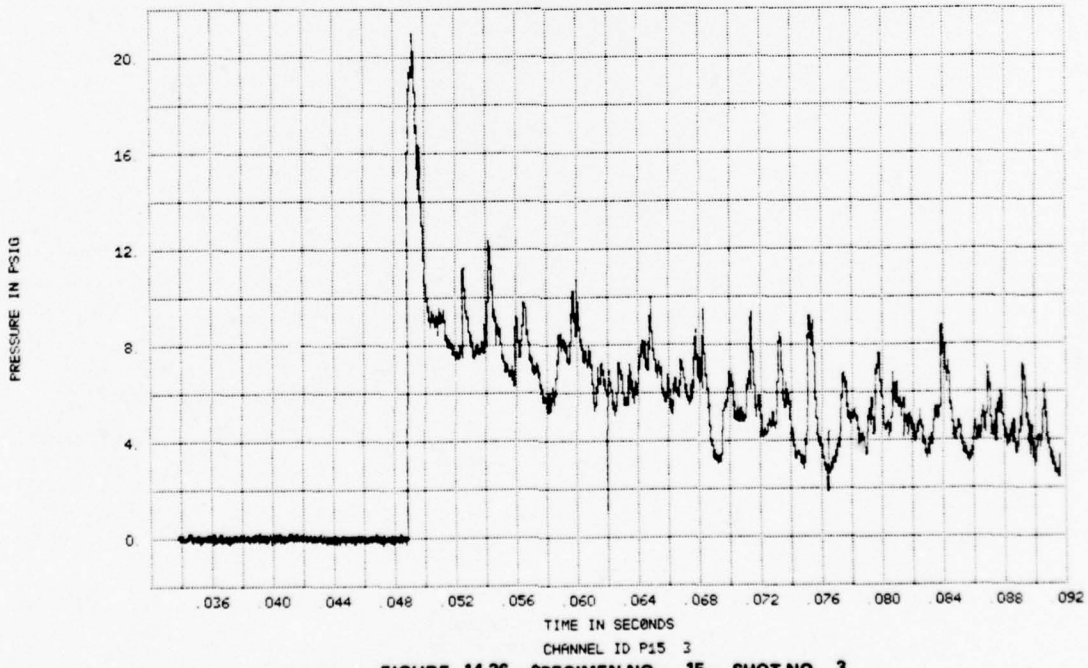


FIGURE 14-36 , SPECIMEN NO. 15 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

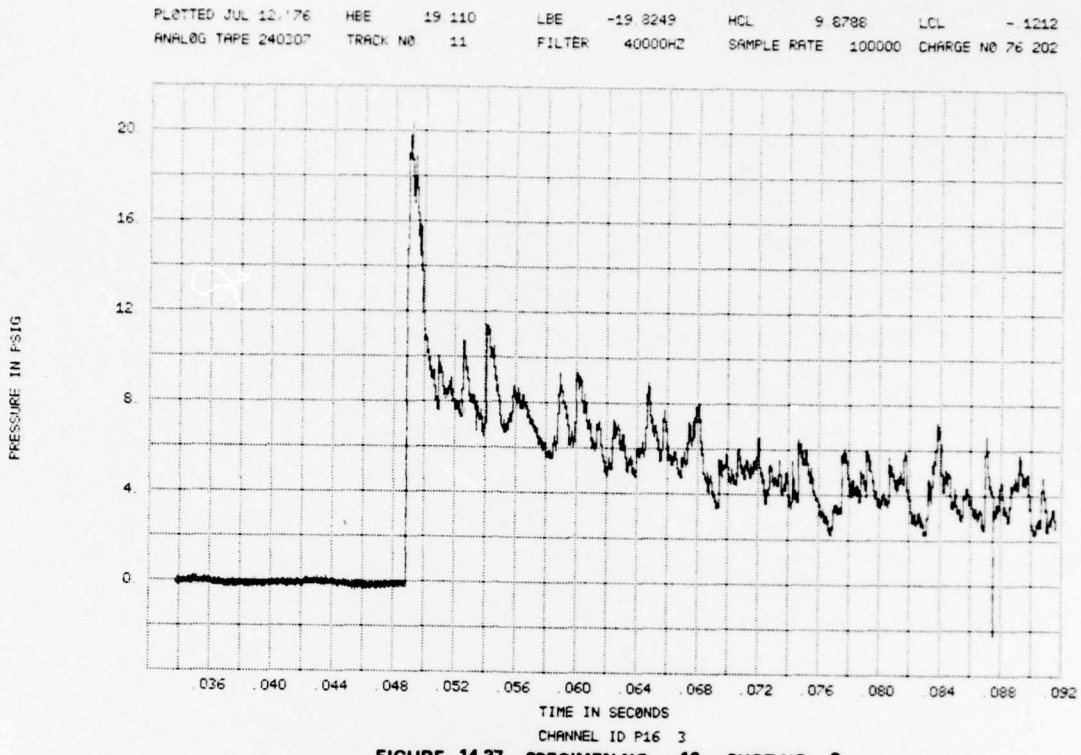


FIGURE 14-37 , SPECIMEN NO. 16 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

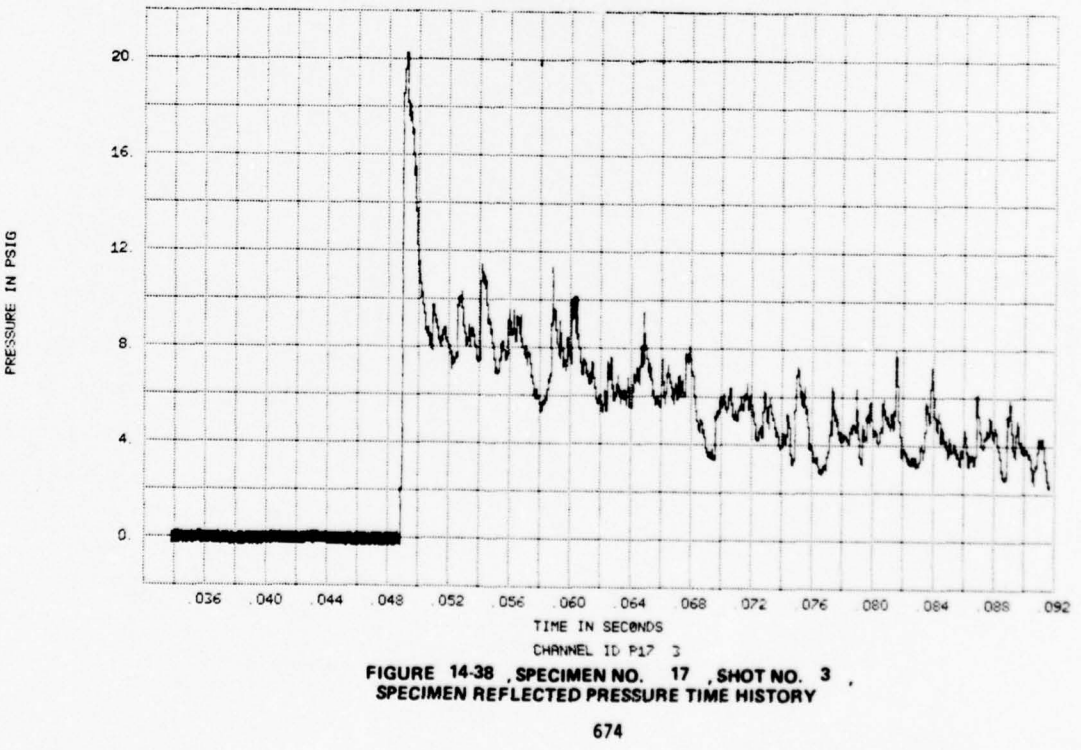


FIGURE 14-38 , SPECIMEN NO. 17 , SHOT NO. 3 ,
SPECIMEN REFLECTED PRESSURE TIME HISTORY

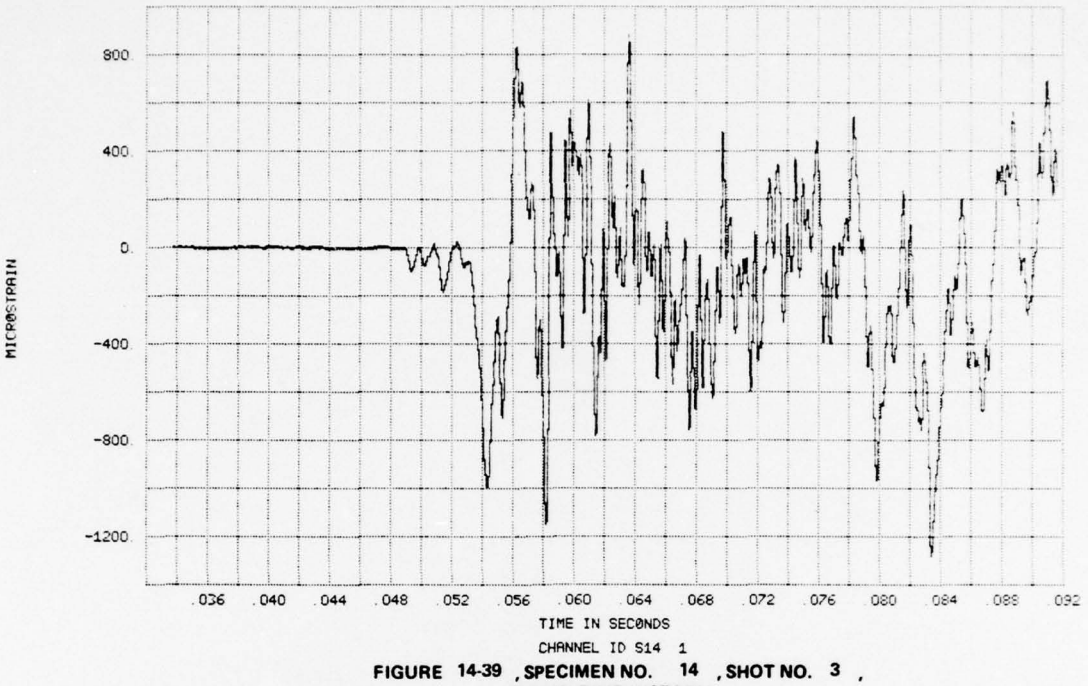


FIGURE 14-39 , SPECIMEN NO. 14 , SHOT NO. 3 , STRAIN TIME HISTORY

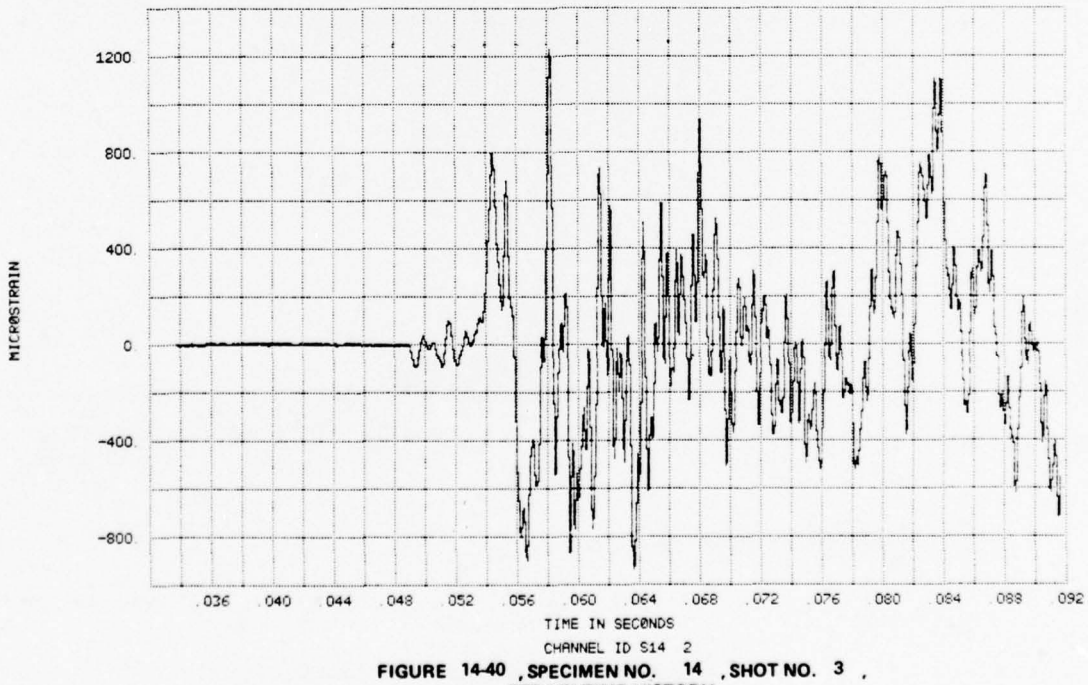


FIGURE 14-40 , SPECIMEN NO. 14 , SHOT NO. 3 , STRAIN TIME HISTORY

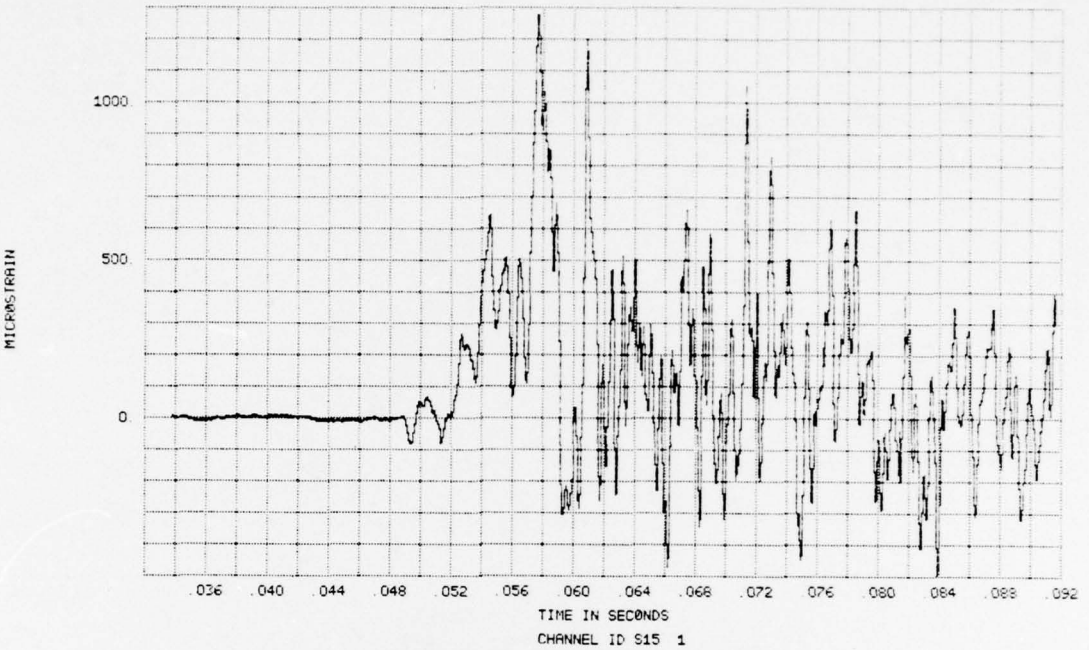


FIGURE 14-41 , SPECIMEN NO. 15 , SHOT NO. 3 , STRAIN TIME HISTORY

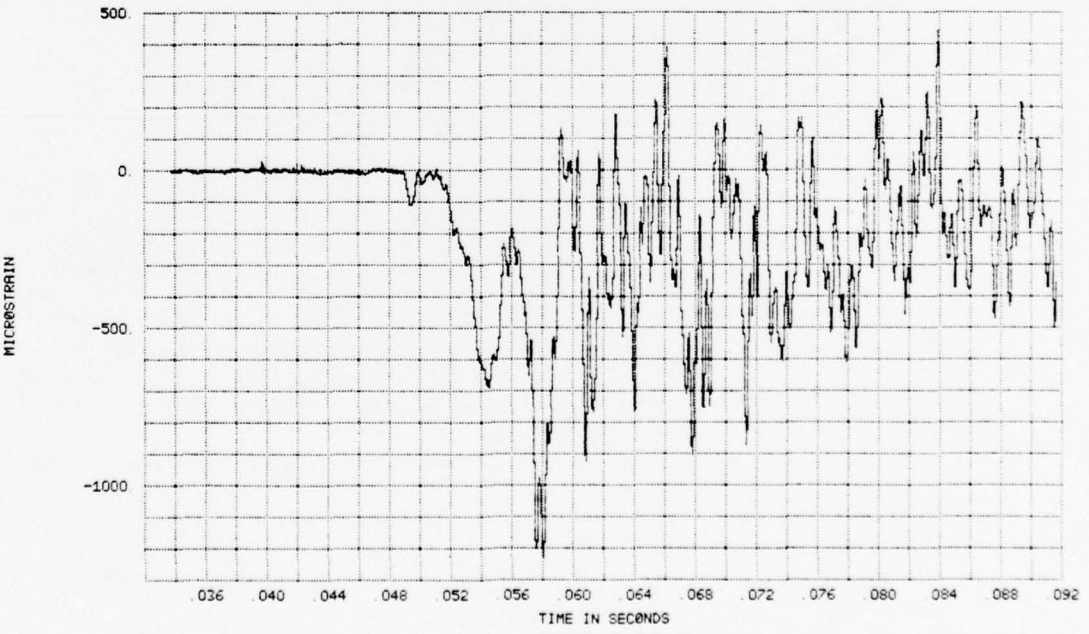


FIGURE 14-42 , SPECIMEN NO. 15 , SHOT NO. 3 , STRAIN TIME HISTORY

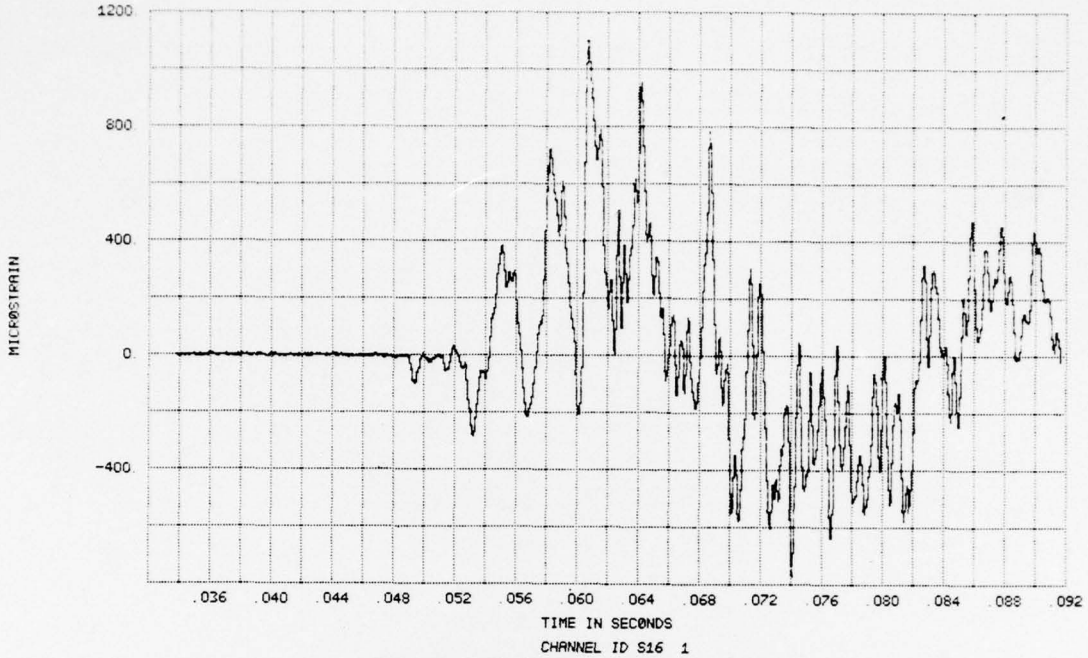


FIGURE 14-43 , SPECIMEN NO. 16 , SHOT NO. 3 ,
STRAIN TIME HISTORY

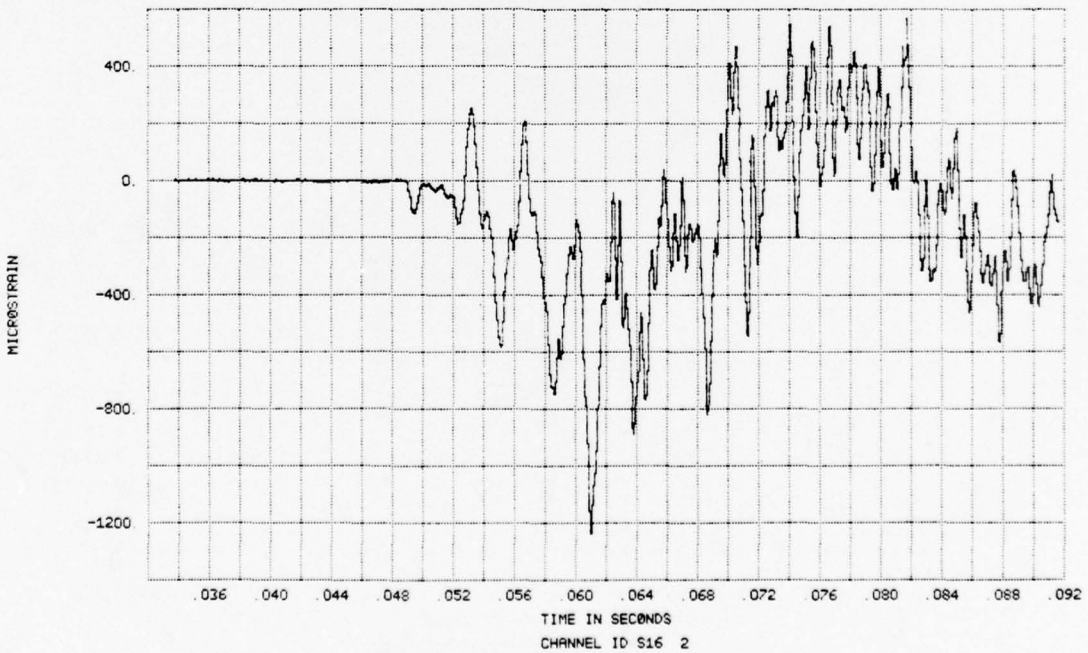


FIGURE 14-44 , SPECIMEN NO. 16 , SHOT NO. 3 ,
STRAIN TIME HISTORY

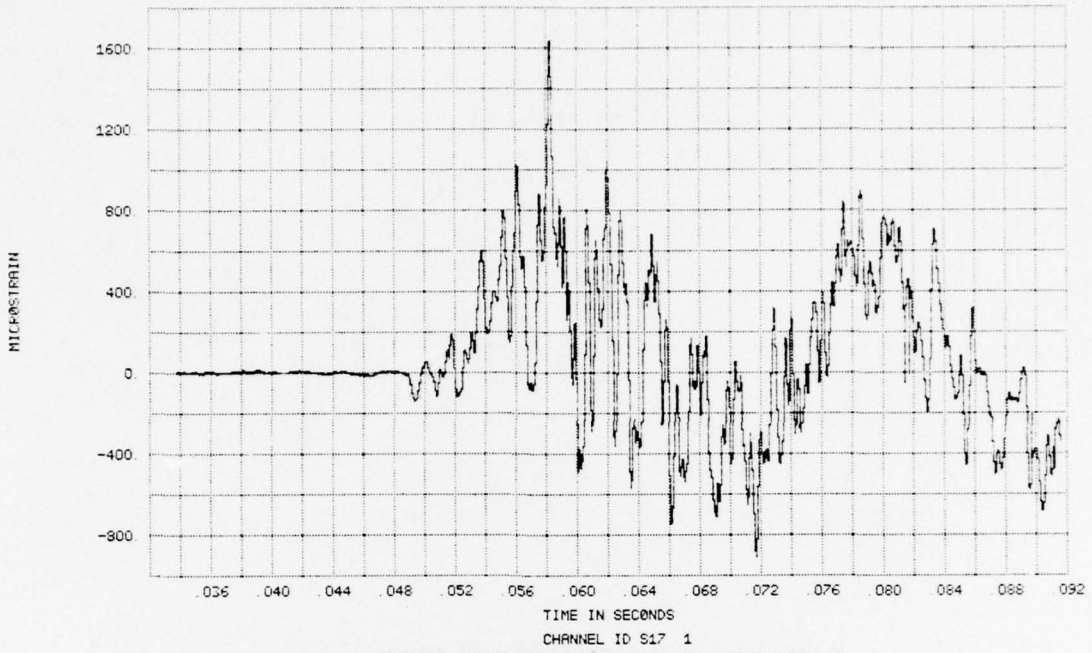


FIGURE 14-45 , SPECIMEN NO. 17 , SHOT NO. 3 , STRAIN TIME HISTORY

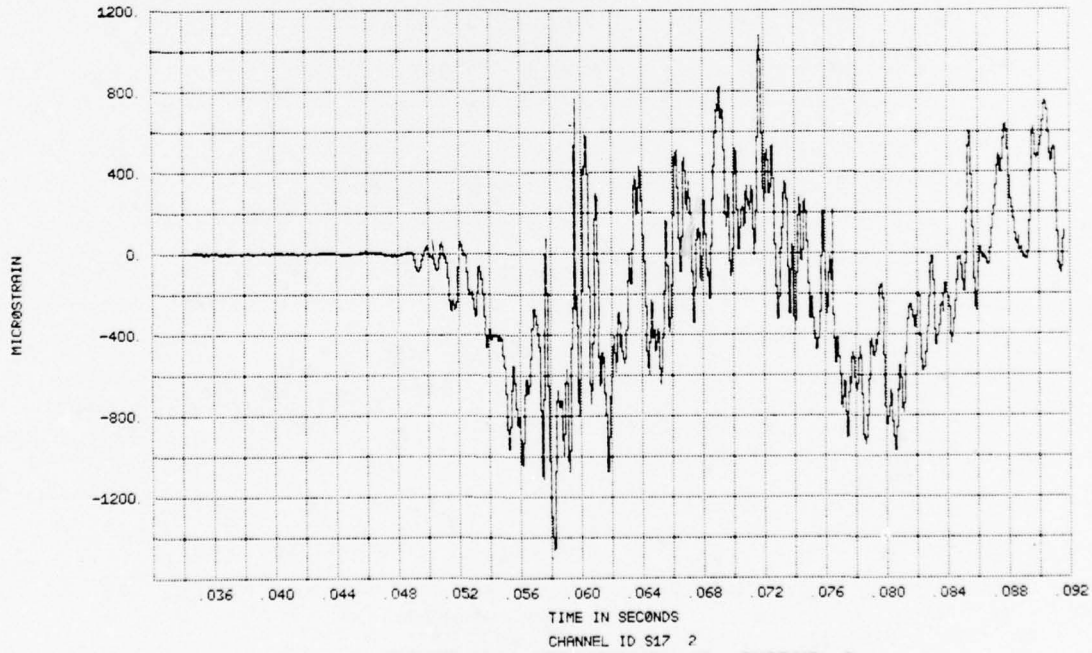


FIGURE 14-46 , SPECIMEN NO. 17 , SHOT NO. 3 , STRAIN TIME HISTORY

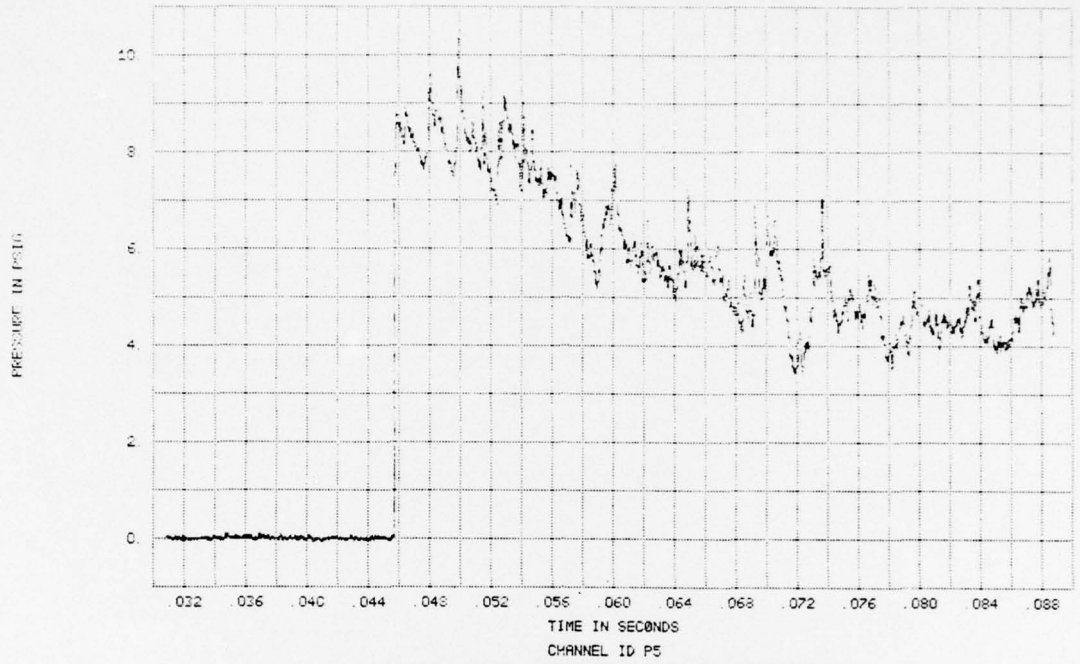


FIGURE 14-47 , SPECIMEN NO. 14-17 , SHOT NO. 4 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

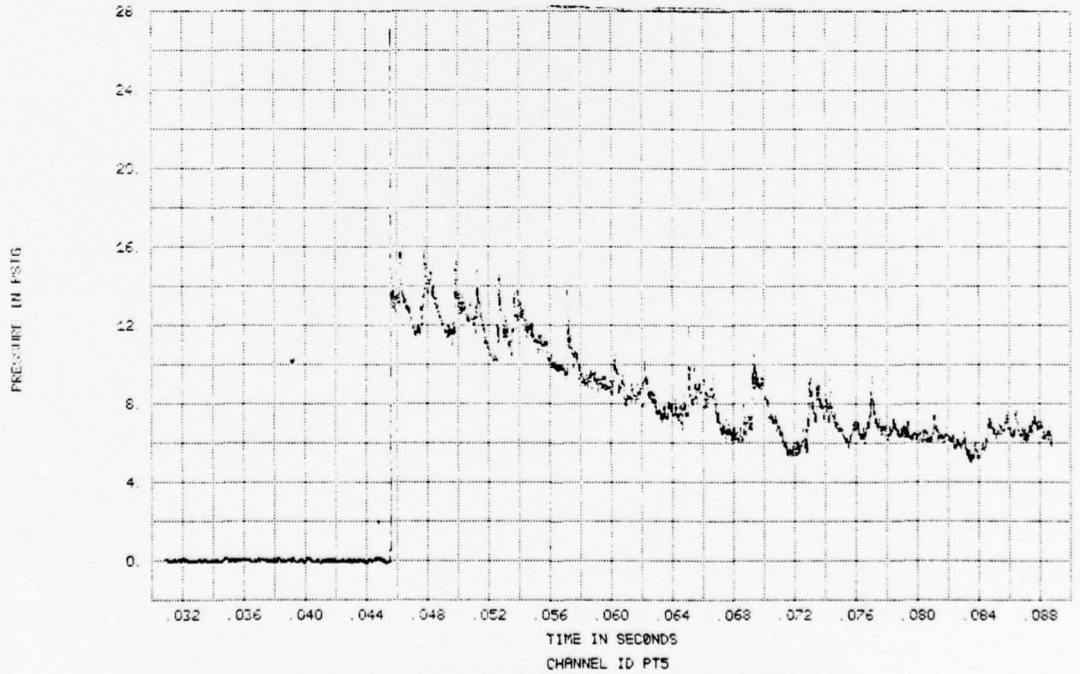


FIGURE 14-48 , SPECIMEN NO. 14-17 , SHOT NO. 4 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

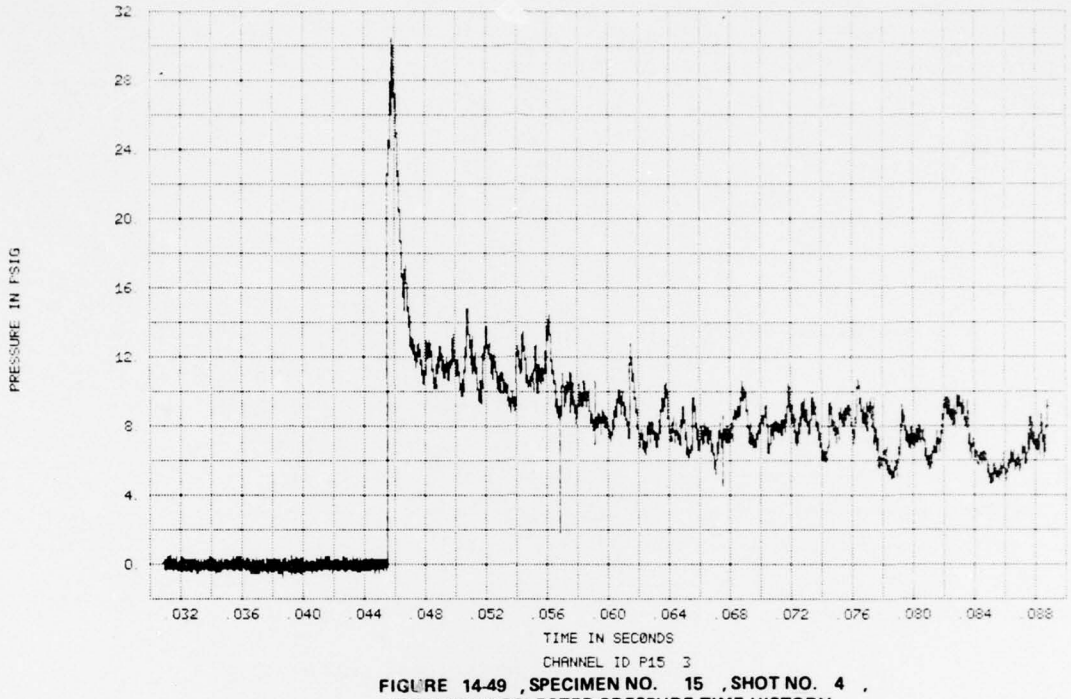


FIGURE 14-49 , SPECIMEN NO. 15 , SHOT NO. 4 , SPECIMEN REFLECTED PRESSURE TIME HISTORY

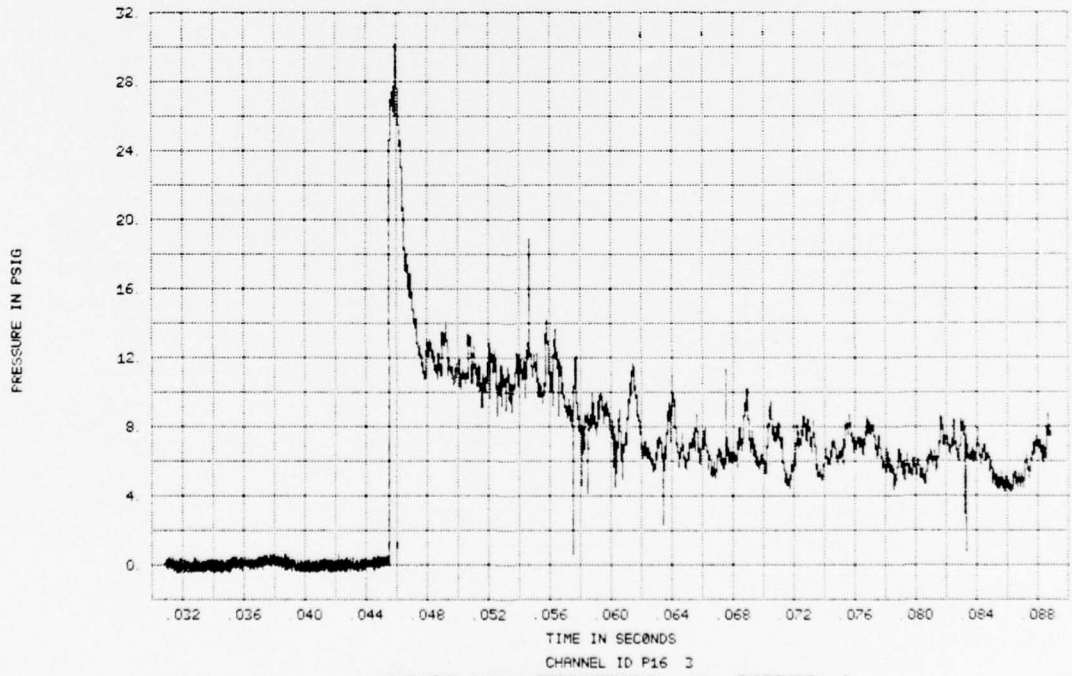


FIGURE 14-50 . SPECIMEN NO. 16 , SHOT NO. 4 , SPECIMEN REFLECTED PRESSURE TIME HISTORY

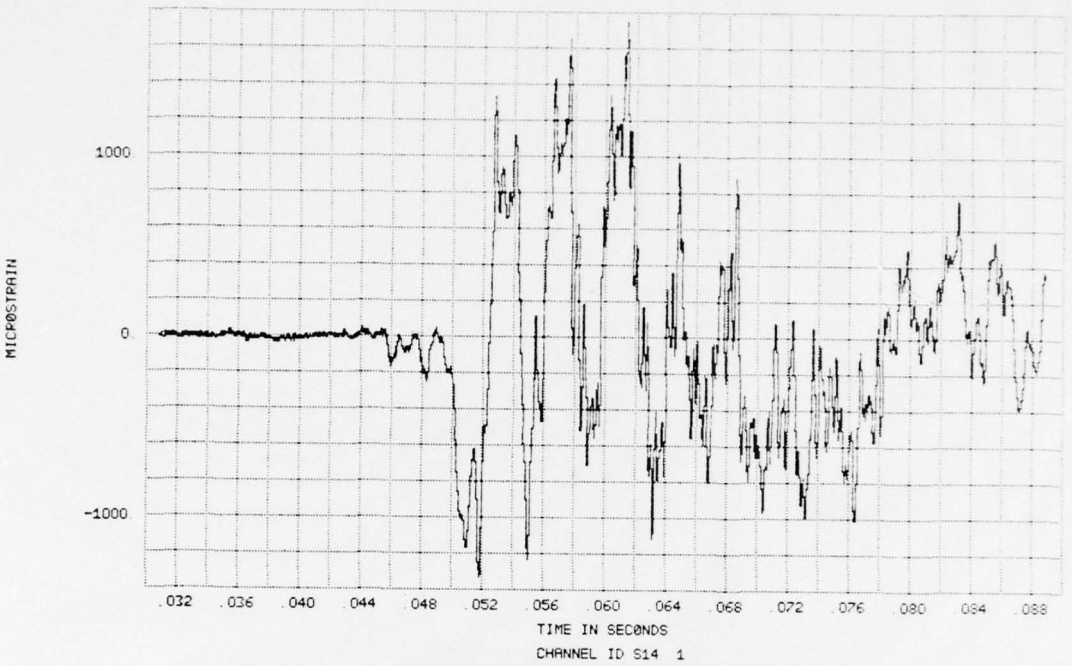


FIGURE 14-51 , SPECIMEN NO. 14 , SHOT NO. 4 , STRAIN TIME HISTORY

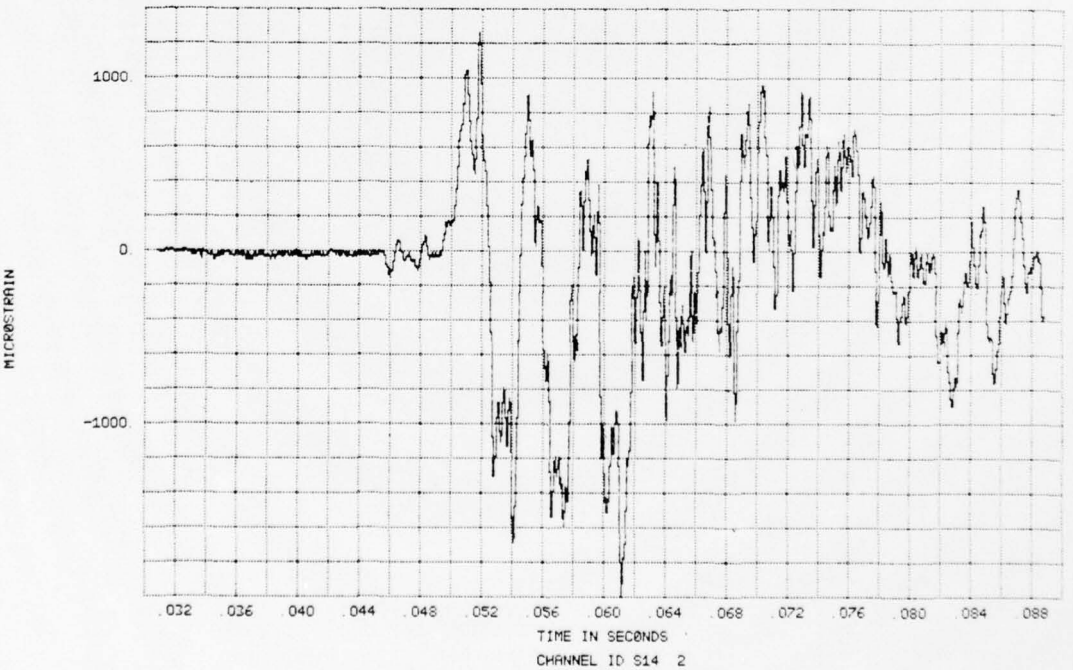


FIGURE 14-52 , SPECIMEN NO. 14 , SHOT NO. 4 , STRAIN TIME HISTORY

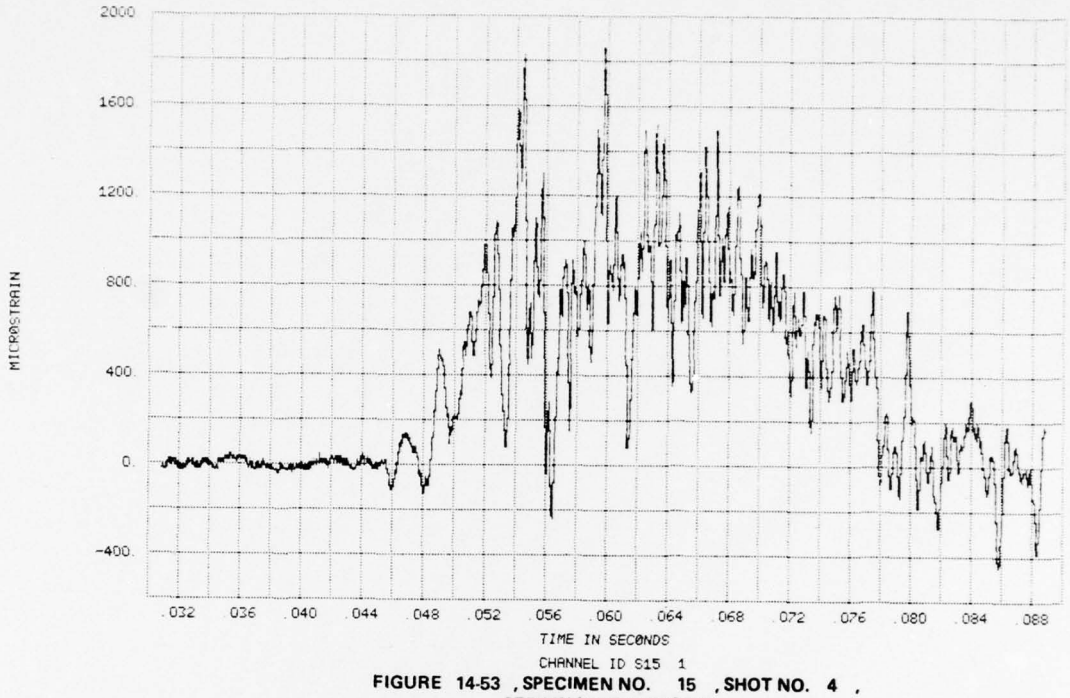


FIGURE 14-53 , SPECIMEN NO. 15 , SHOT NO. 4 , STRAIN TIME HISTORY

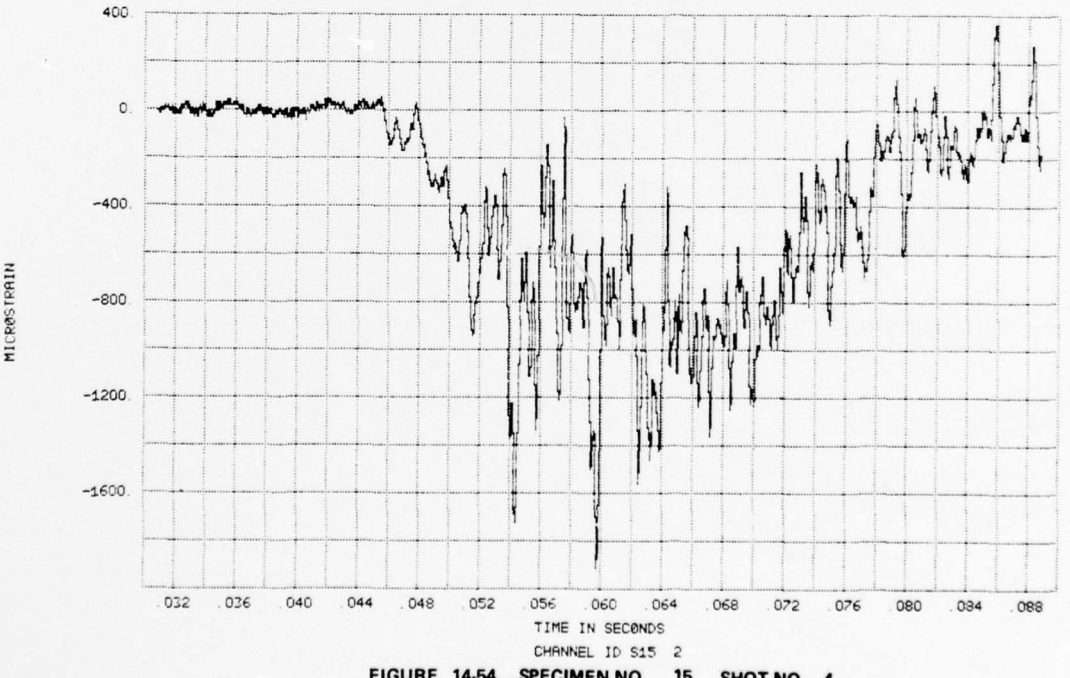


FIGURE 14-54 , SPECIMEN NO. 15 , SHOT NO. 4 , STRAIN TIME HISTORY

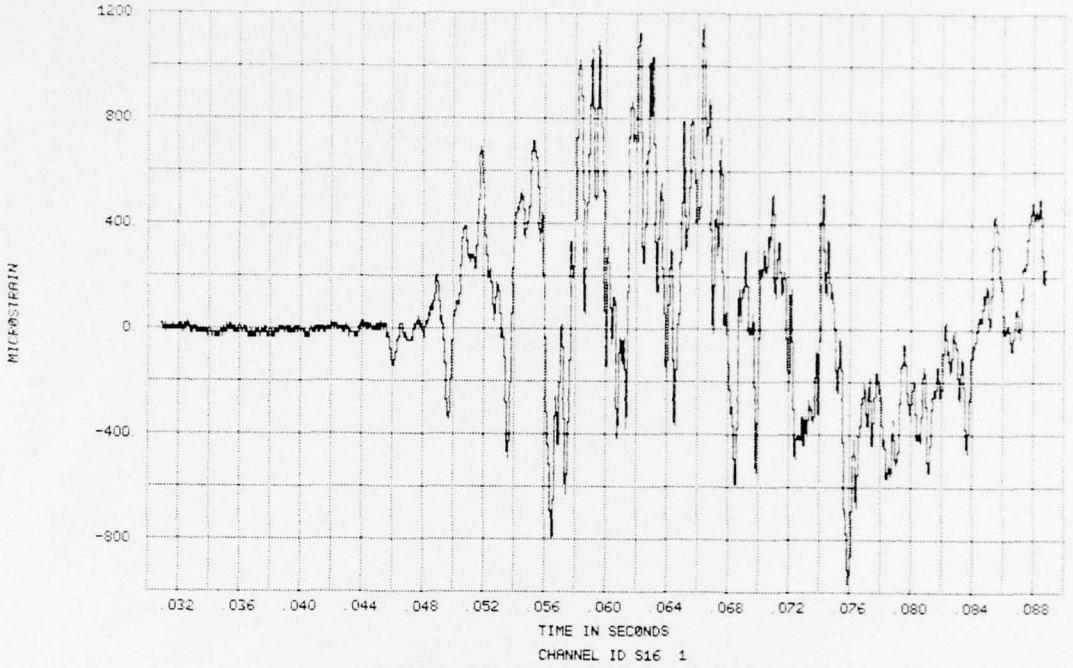


FIGURE 14-55 , SPECIMEN NO. 16 , SHOT NO. 4 , STRAIN TIME HISTORY

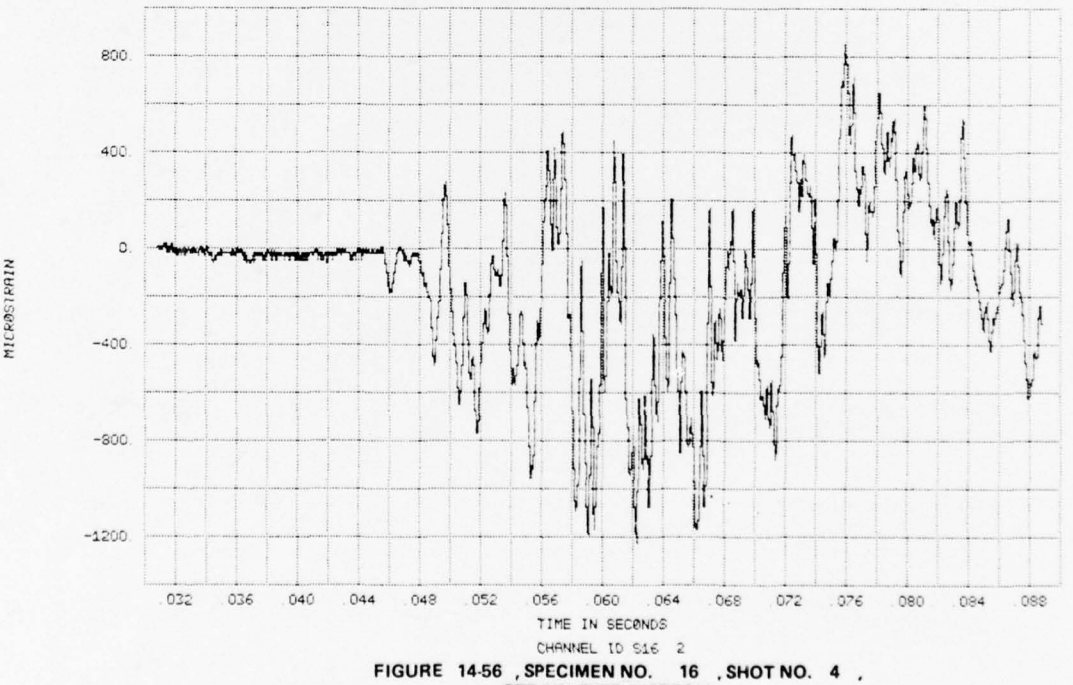


FIGURE 14-56 , SPECIMEN NO. 16 , SHOT NO. 4 , STRAIN TIME HISTORY

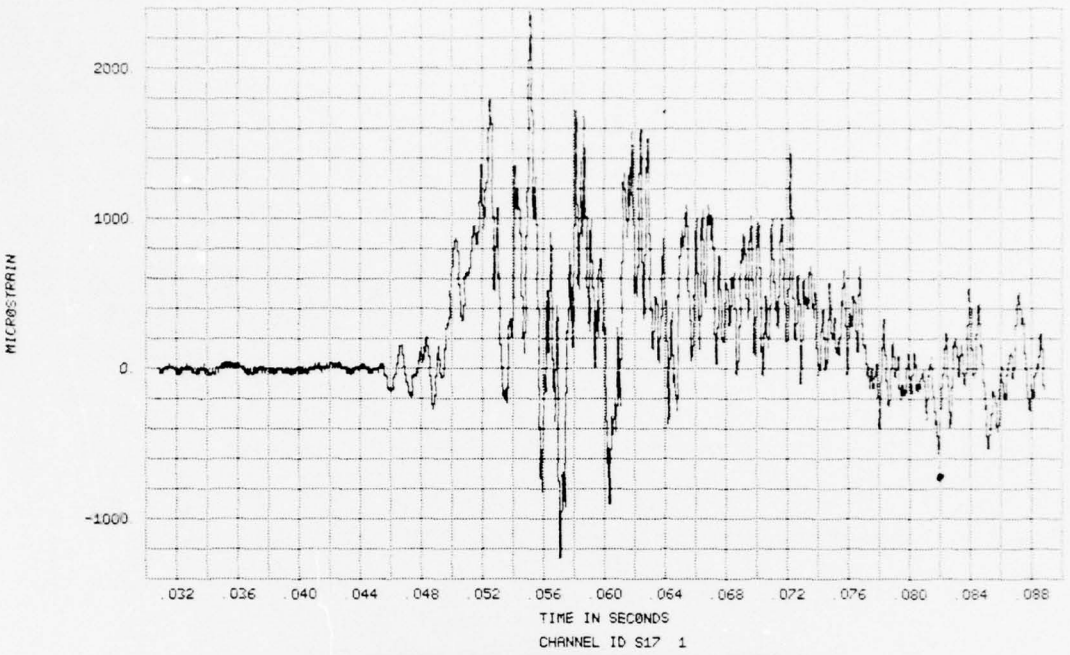


FIGURE 14-57 , SPECIMEN NO. 17 , SHOT NO. 4 , STRAIN TIME HISTORY

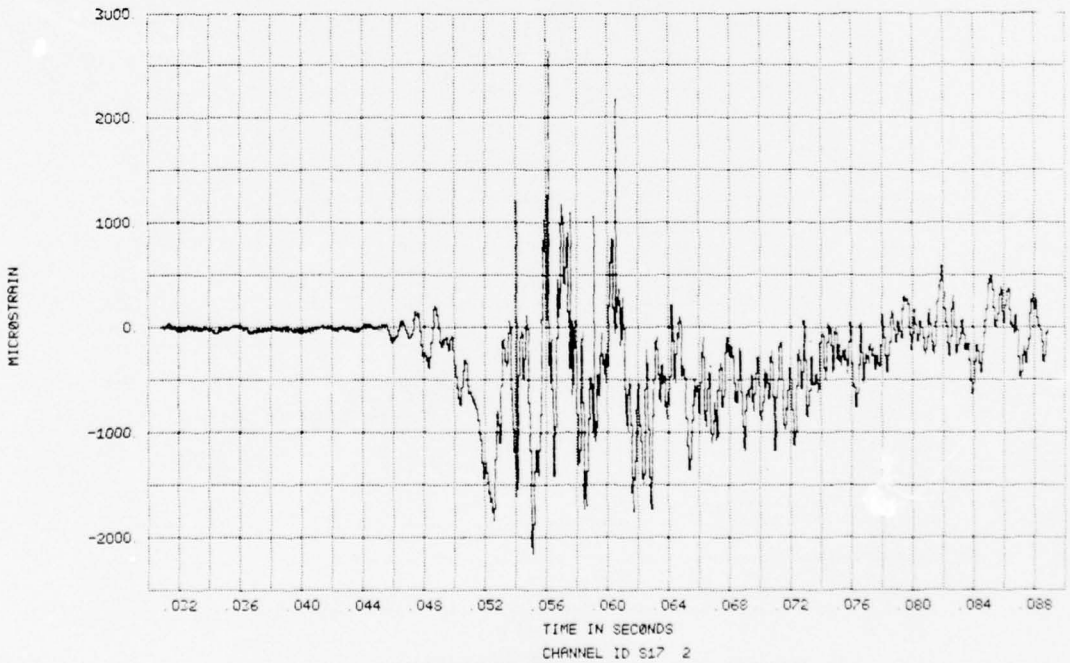


FIGURE 14-58 , SPECIMEN NO. 17 , SHOT NO. 4 , STRAIN TIME HISTORY

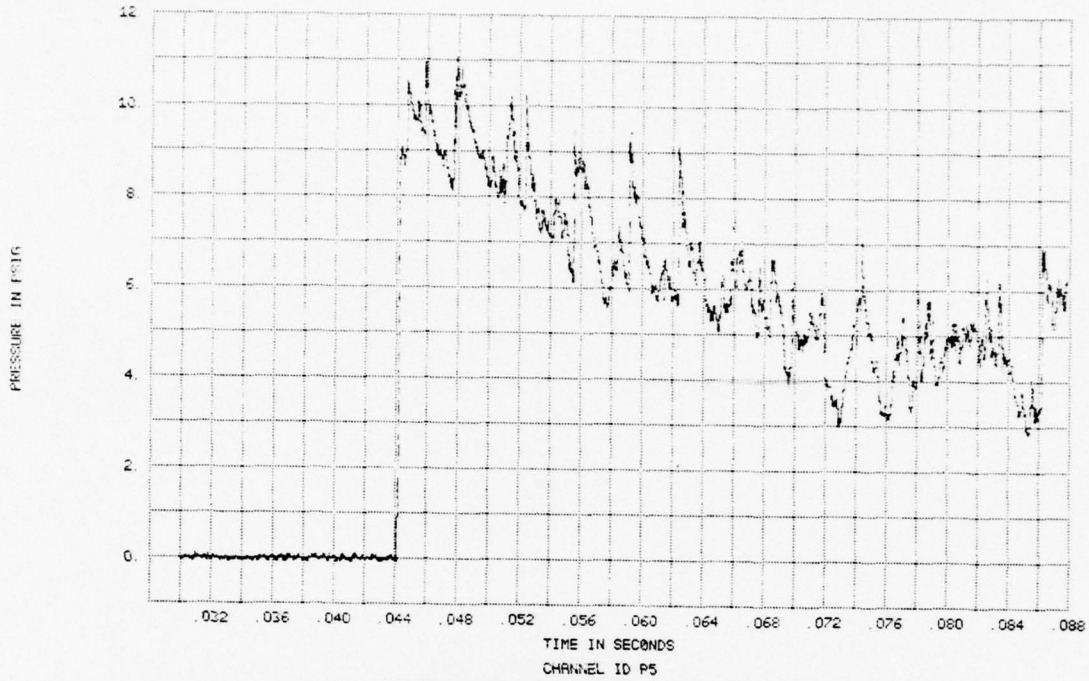


FIGURE 14-59 , SPECIMEN NO. 14-17 , SHOT NO. 5 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

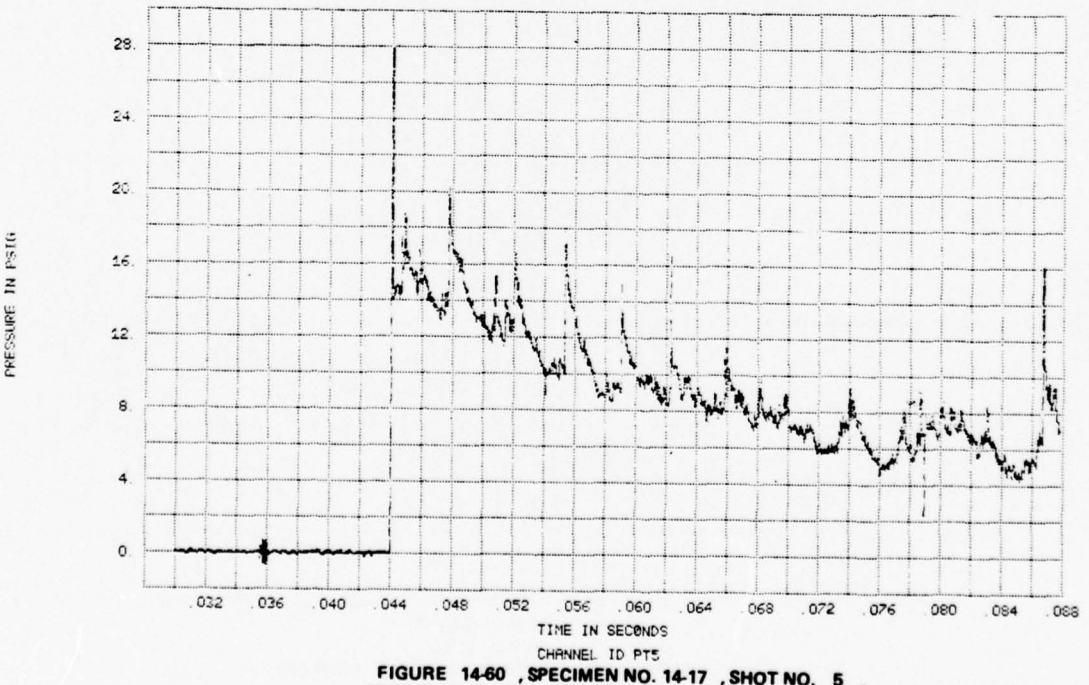


FIGURE 14-60 , SPECIMEN NO. 14-17 , SHOT NO. 5 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

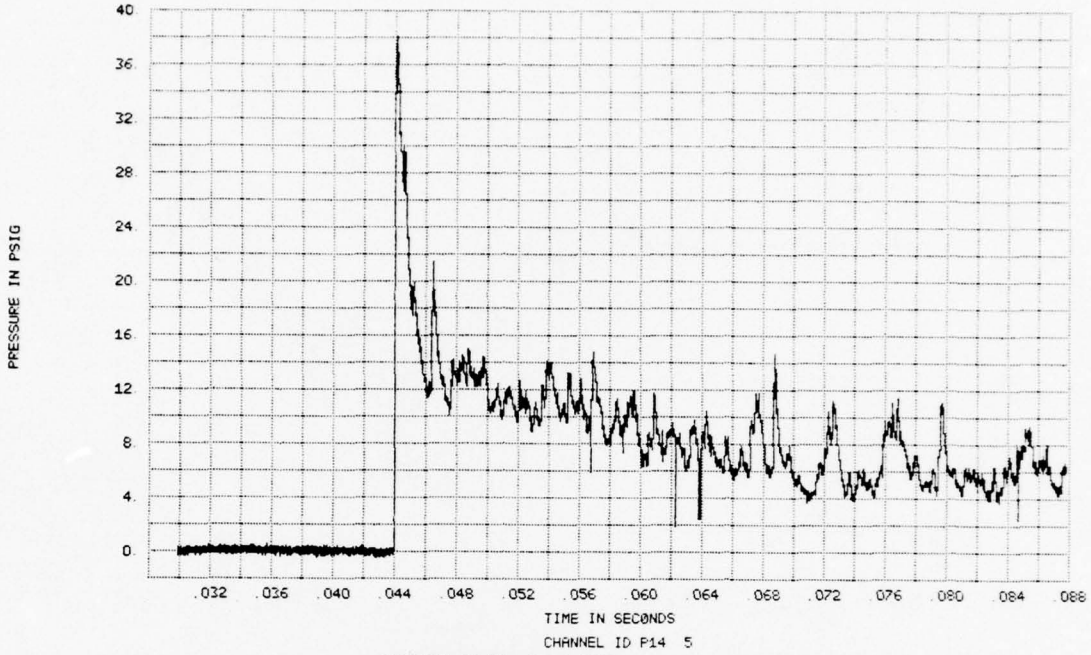


FIGURE 14-61 , SPECIMEN NO. 14 , SHOT NO. 5 , SPECIMEN REFLECTED PRESSURE TIME HISTORY

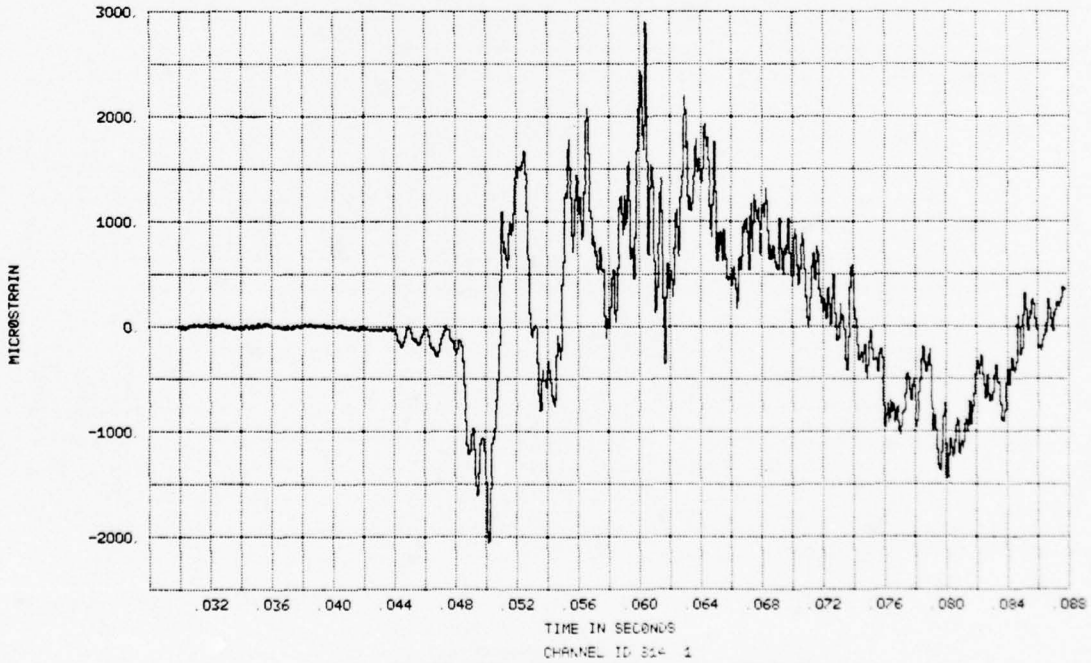


FIGURE 14-62 , SPECIMEN NO. 14 , SHOT NO. 5 , STRAIN TIME HISTORY

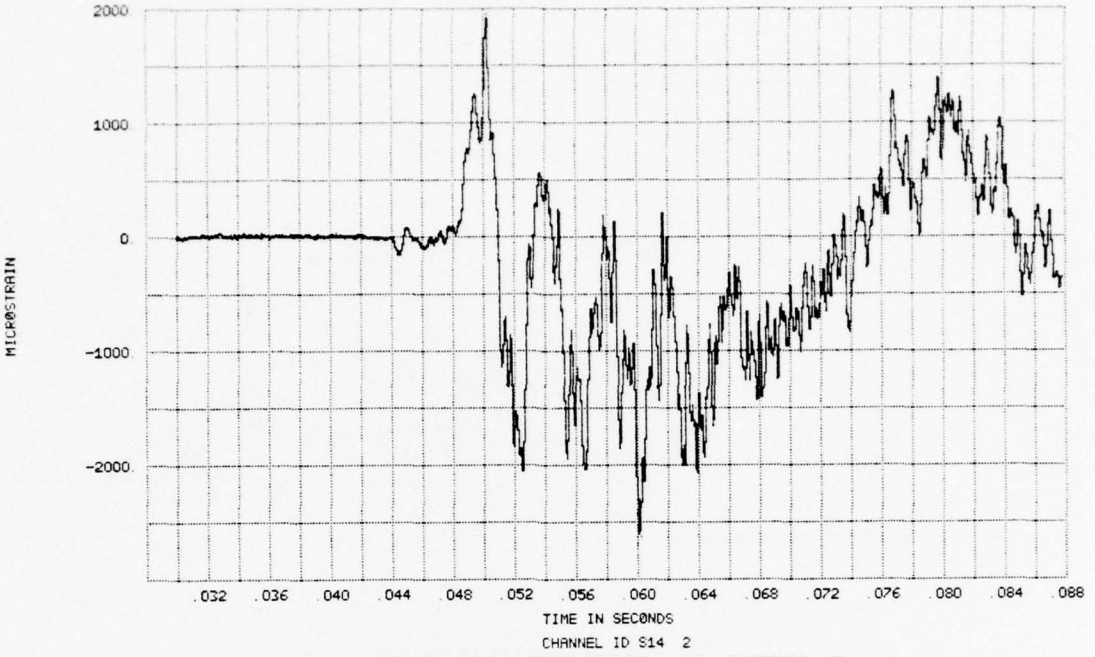


FIGURE 14-63 , SPECIMEN NO. 14 , SHOT NO. 5 ,
STRAIN TIME HISTORY

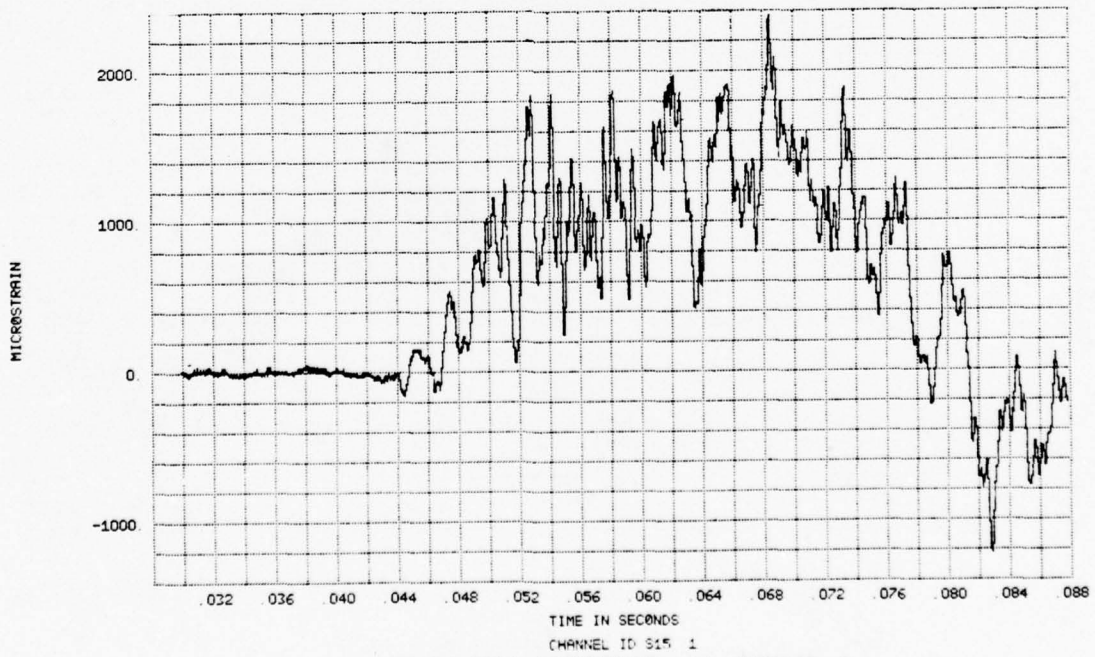


FIGURE 14-64 , SPECIMEN NO. 15 , SHOT NO. 5 ,
STRAIN TIME HISTORY

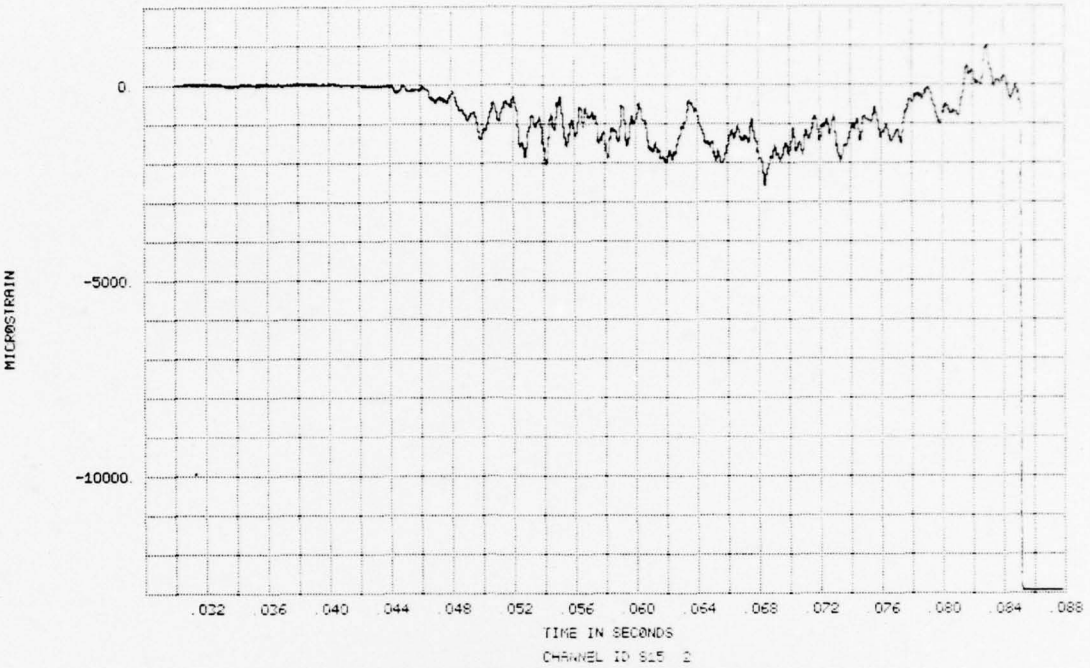


FIGURE 14-65 , SPECIMEN NO. 15 , SHOT NO. 5 , STRAIN TIME HISTORY

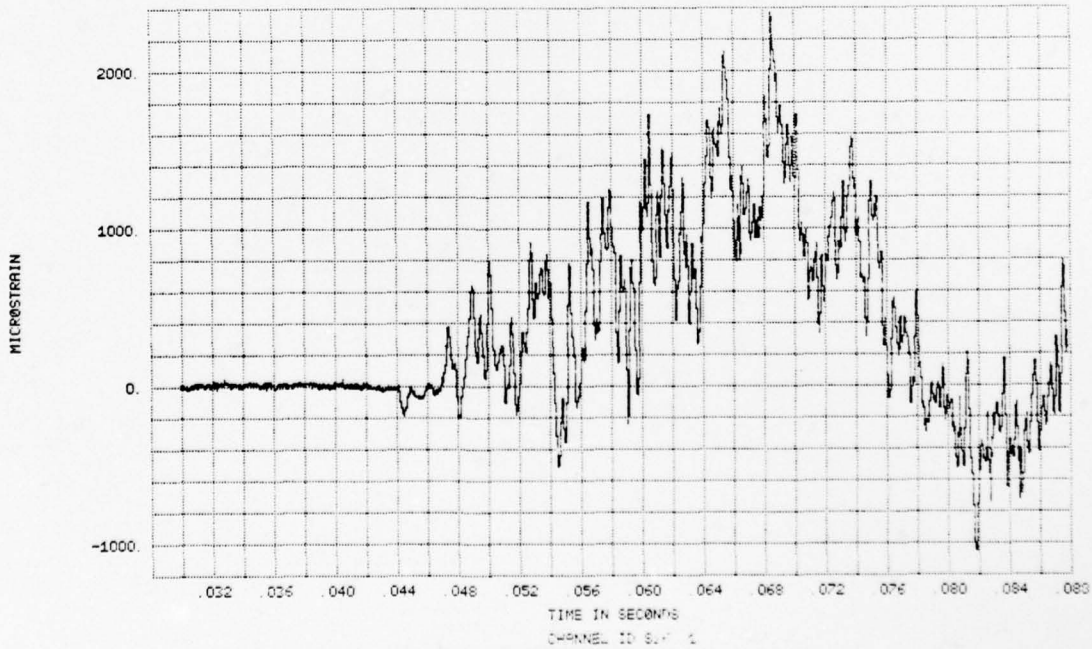


FIGURE 14-66 , SPECIMEN NO. 16 , SHOT NO. 5 , STRAIN TIME HISTORY

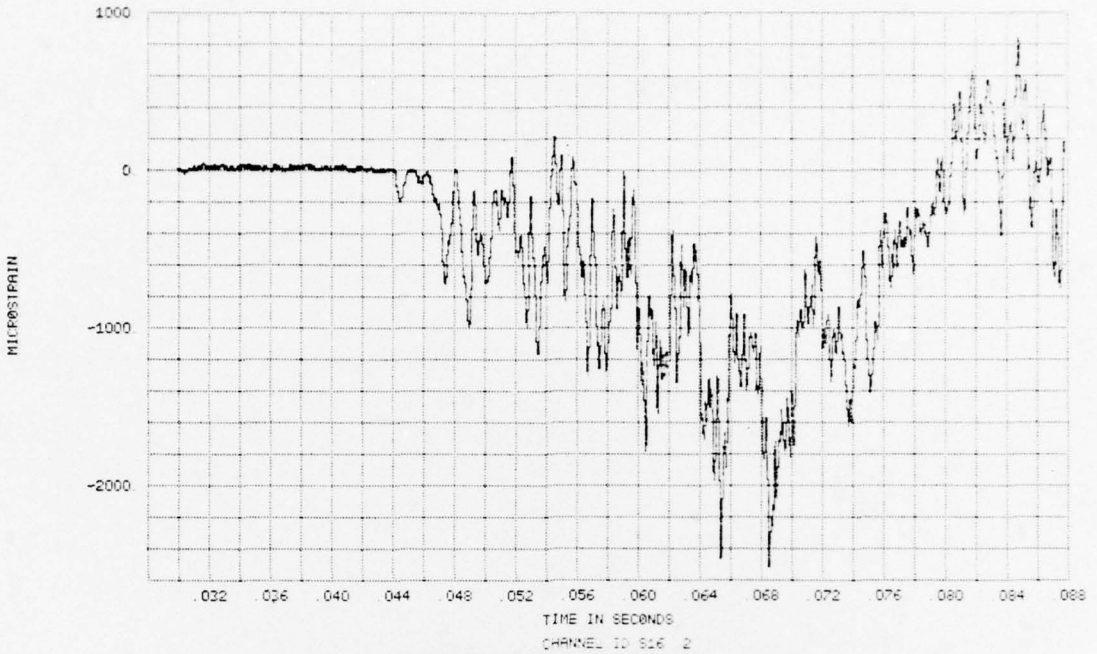


FIGURE 14-67 , SPECIMEN NO. 16 , SHOT NO. 5 , STRAIN TIME HISTORY

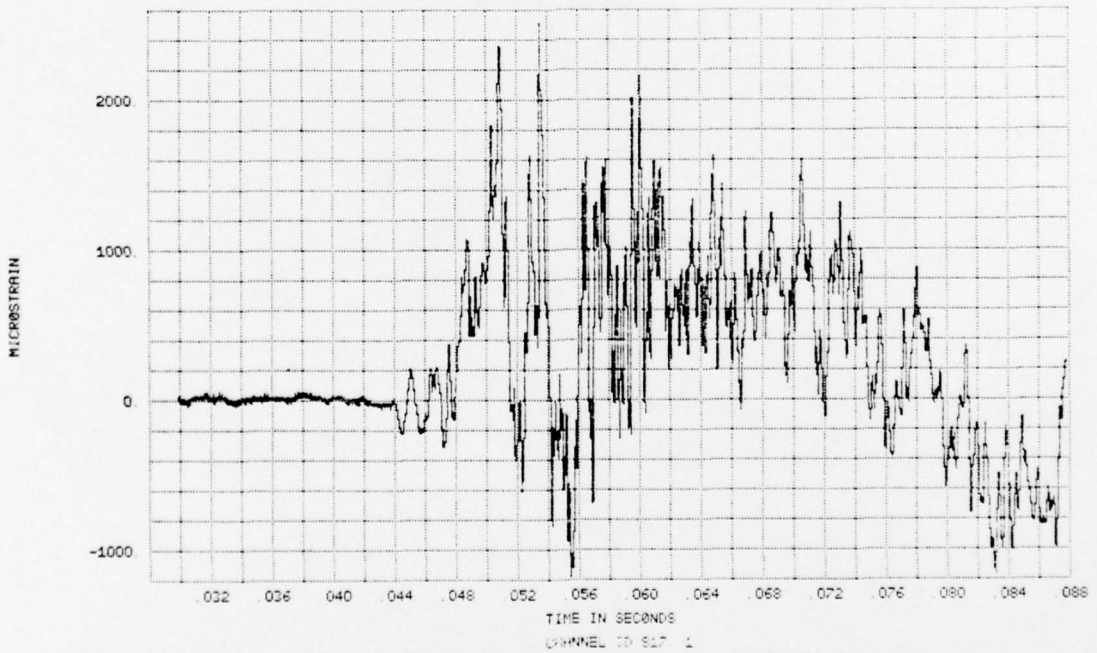


FIGURE 14-68 , SPECIMEN NO. 17 , SHOT NO. 5 , STRAIN TIME HISTORY

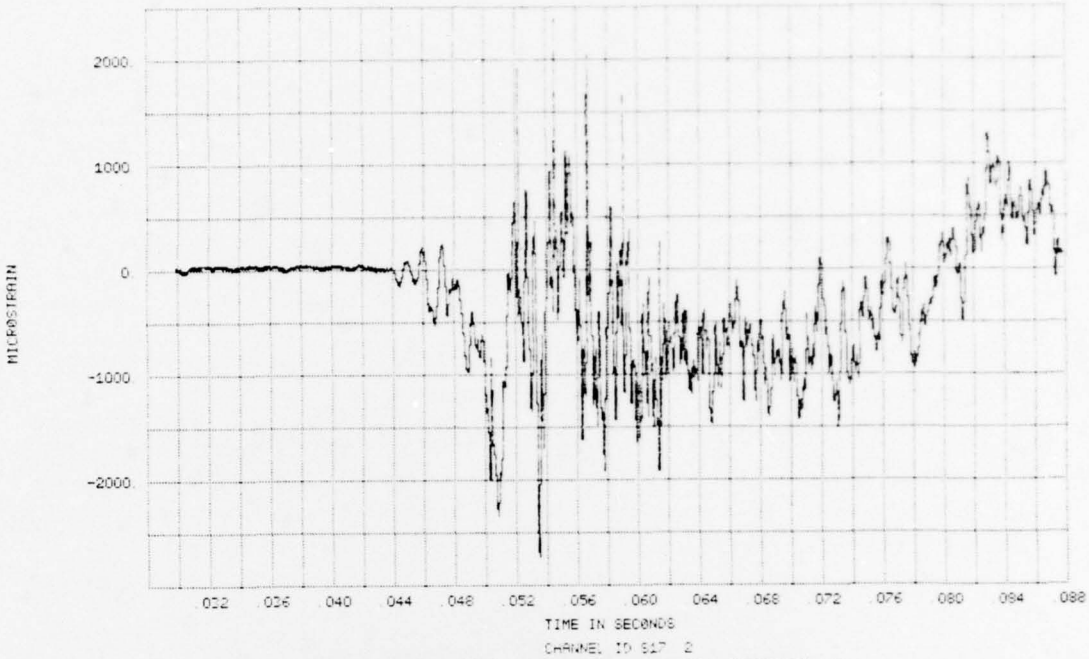


FIGURE 14-69 , SPECIMEN NO. 17 , SHOT NO. 5 , STRAIN TIME HISTORY

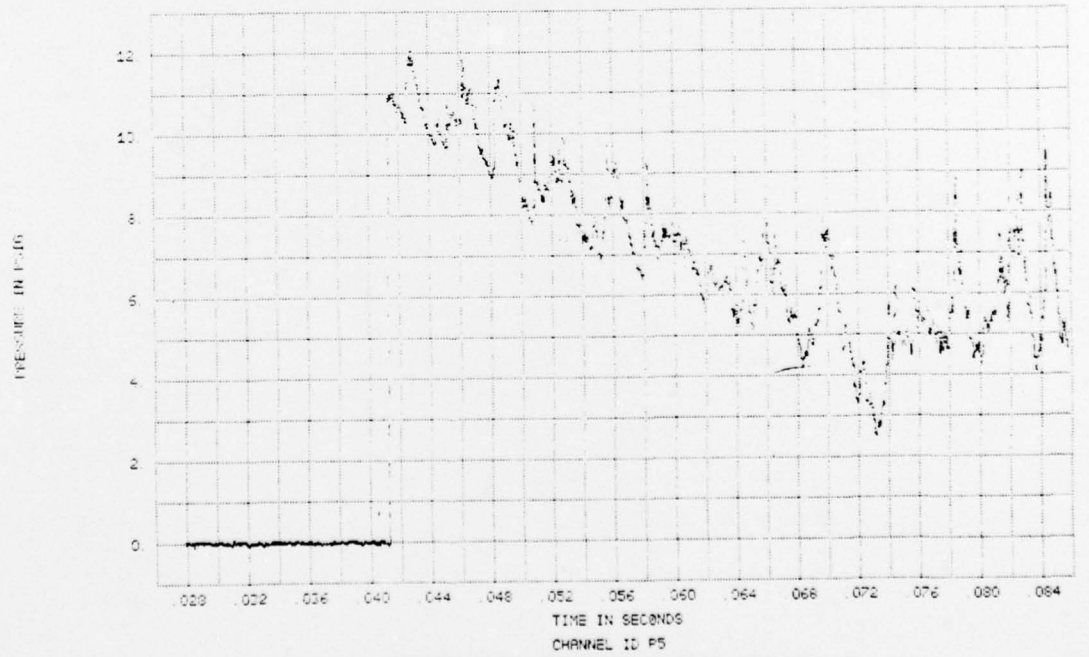


FIGURE 14-70 , SPECIMEN NO. 14-17 , SHOT NO. 6 , TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

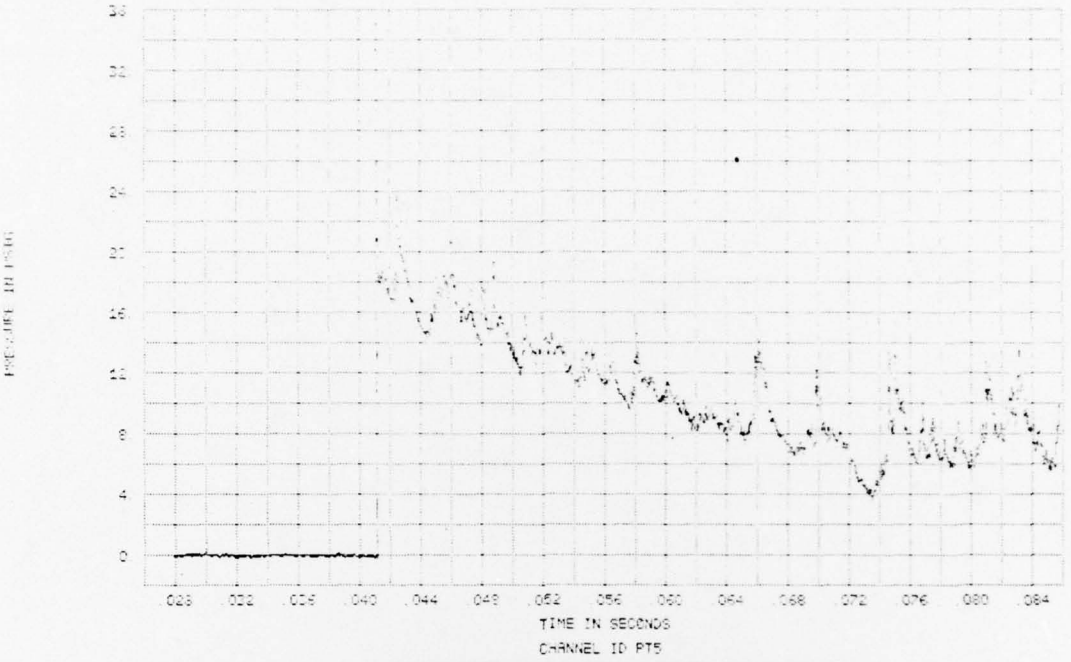


FIGURE 14-71 , SPECIMEN NO. 14-17 , SHOT NO. 6 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

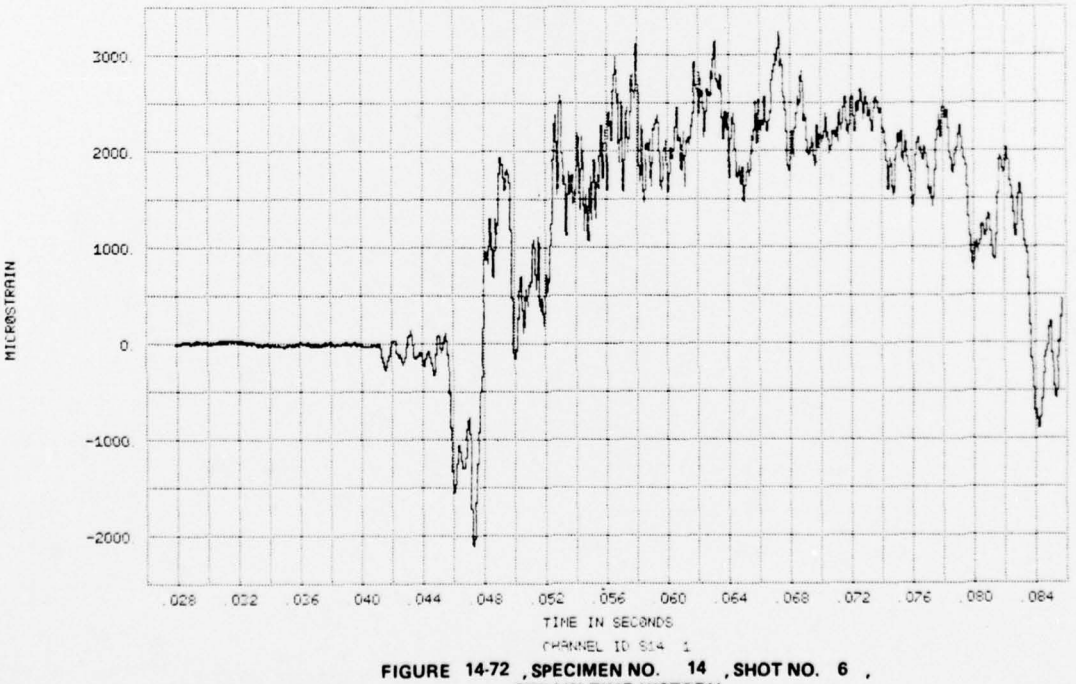


FIGURE 14-72 , SPECIMEN NO. 14 , SHOT NO. 6 ,
STRAIN TIME HISTORY

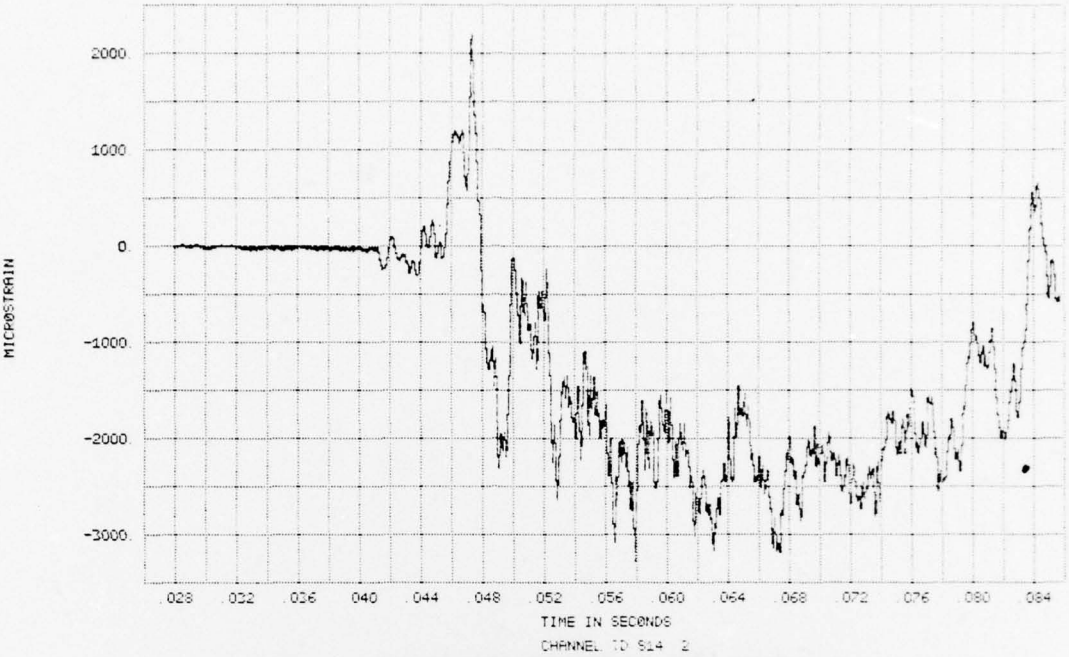


FIGURE 14-73 , SPECIMEN NO. 14 , SHOT NO. 6 , STRAIN TIME HISTORY

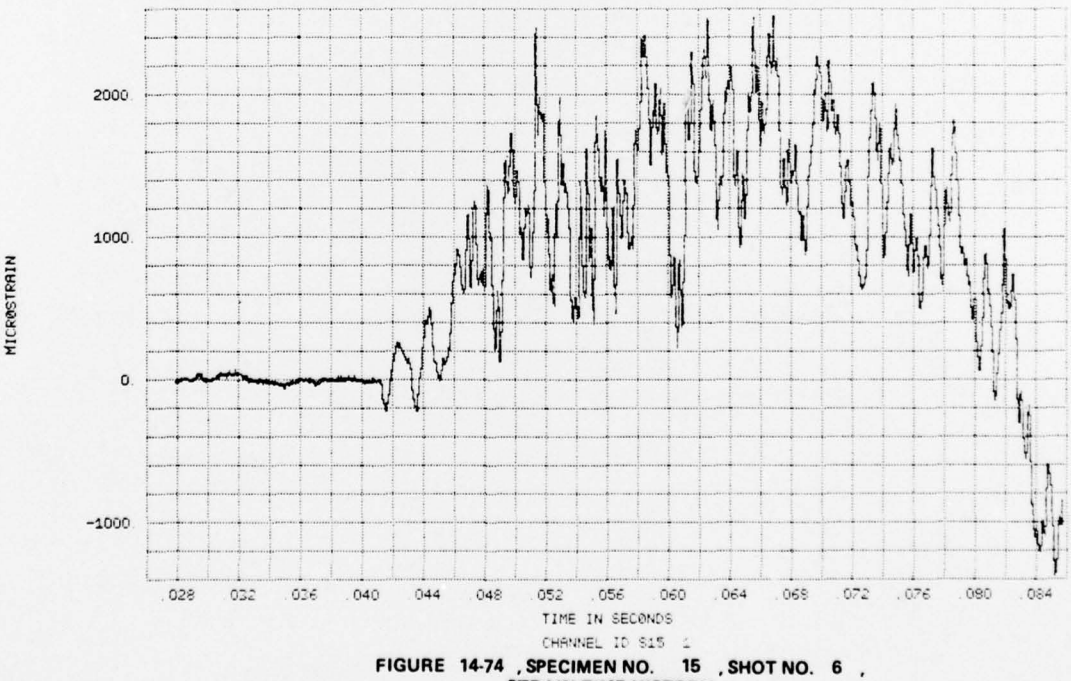


FIGURE 14-74 , SPECIMEN NO. 15 , SHOT NO. 6 , STRAIN TIME HISTORY

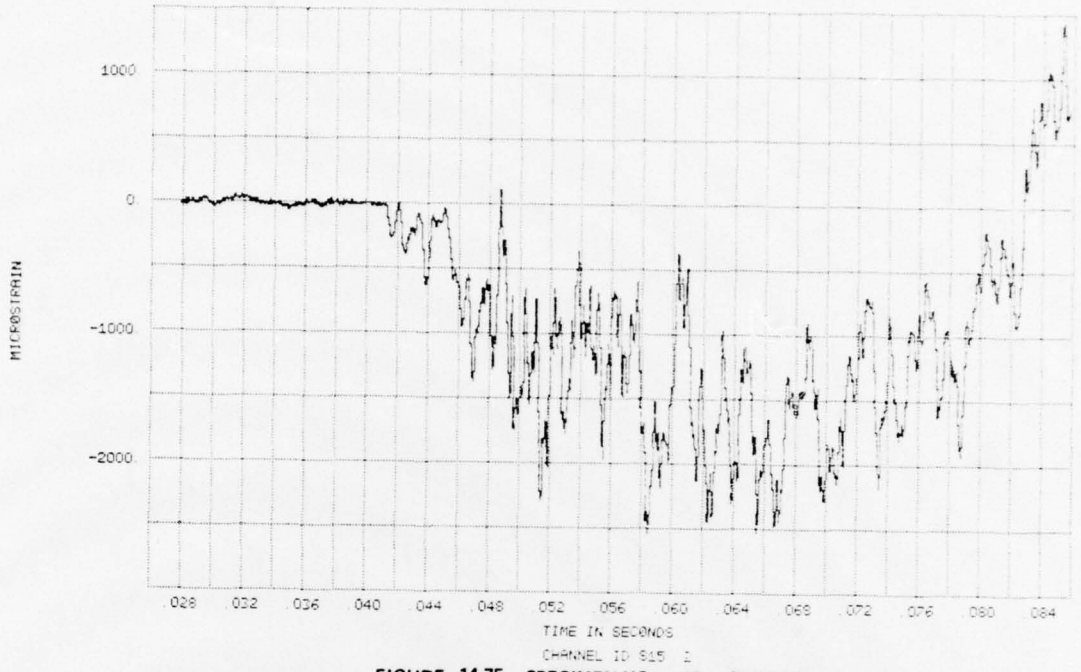


FIGURE 14-75 , SPECIMEN NO. 15 , SHOT NO. 6 , STRAIN TIME HISTORY

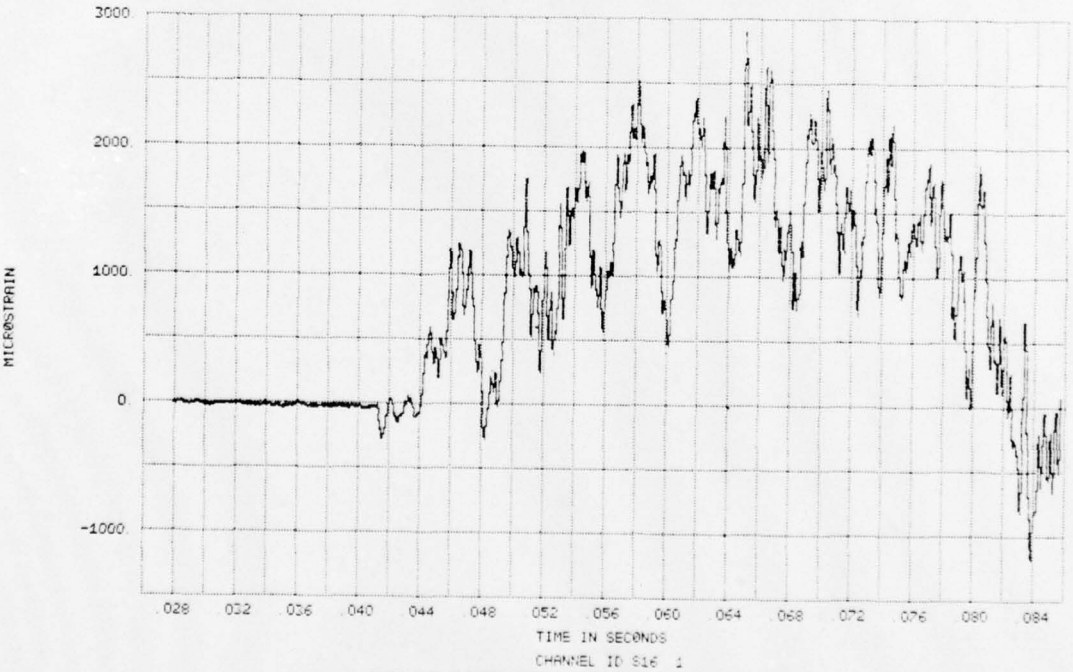


FIGURE 14-76 , SPECIMEN NO. 16 , SHOT NO. 6 , STRAIN TIME HISTORY

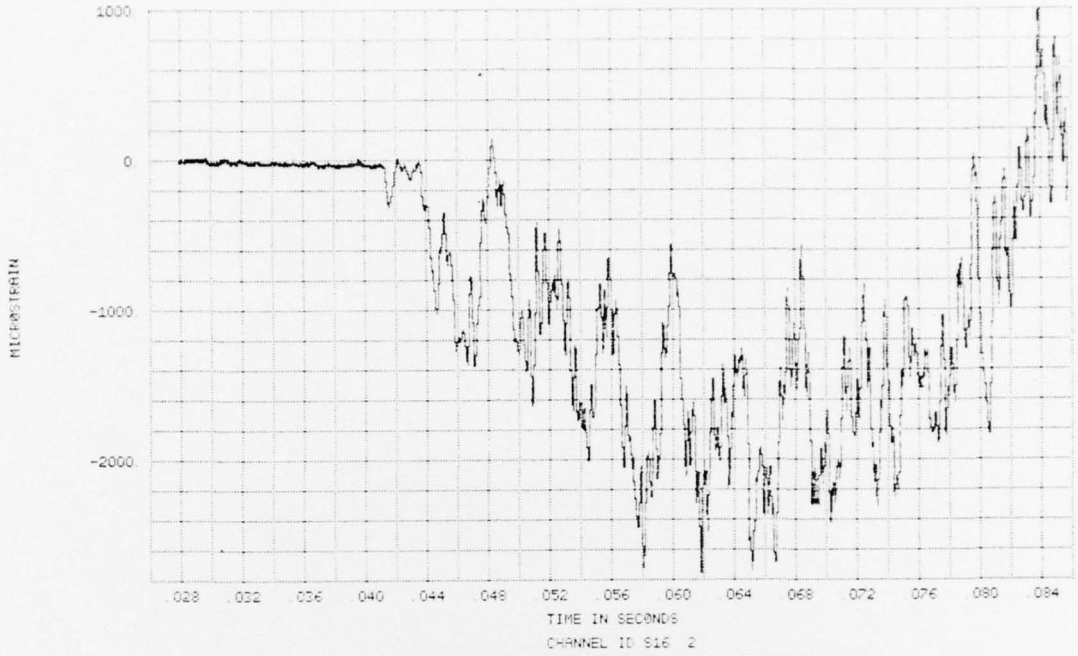


FIGURE 14-77 , SPECIMEN NO. 16 , SHOT NO. 6 , STRAIN TIME HISTORY

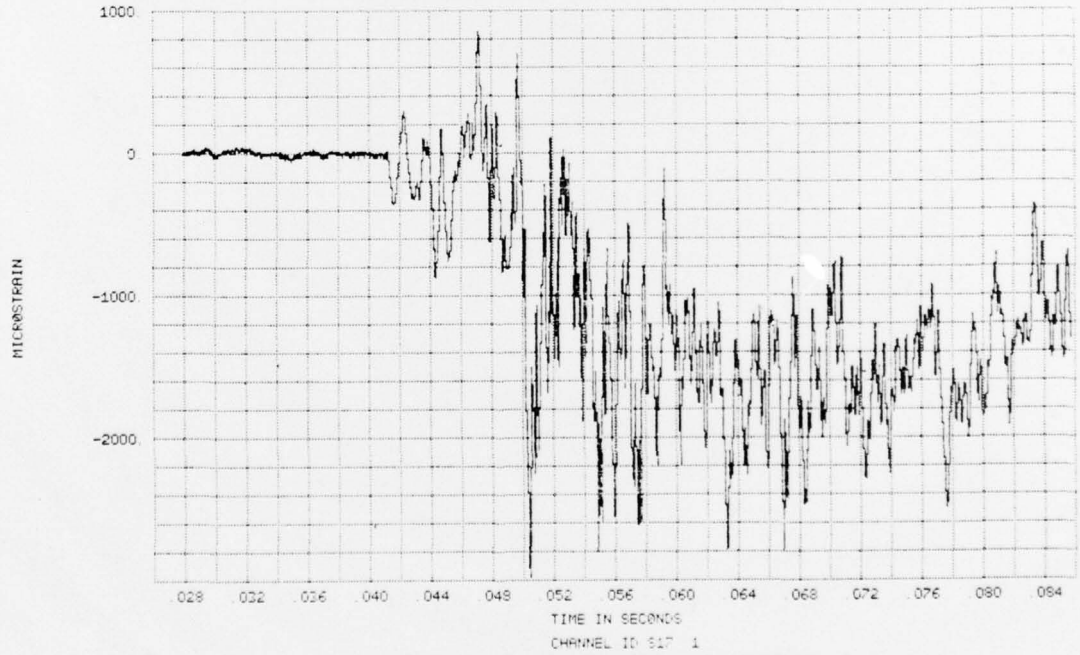


FIGURE 14-78 , SPECIMEN NO. 17 , SHOT NO. 6 , STRAIN TIME HISTORY

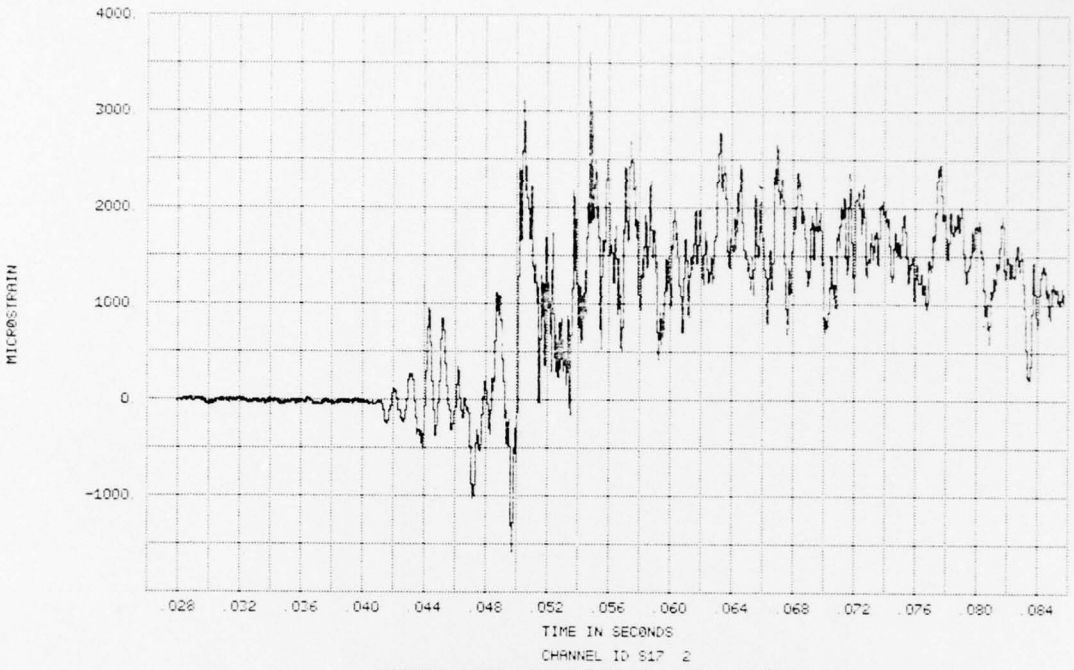


FIGURE 14-79 , SPECIMEN NO. 17 , SHOT NO. 6 ,
STRAIN TIME HISTORY

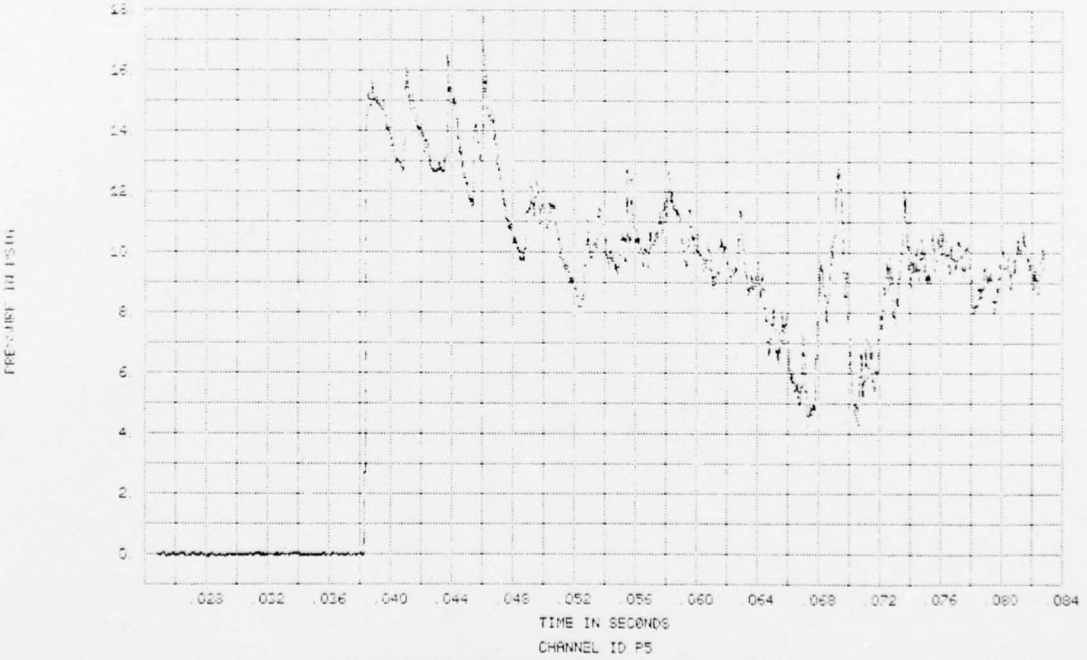


FIGURE 14-80 , SPECIMEN NO. 14-17 , SHOT NO. 7 ,
TUNNEL WALL INCIDENT OVERPRESSURE TIME HISTORY

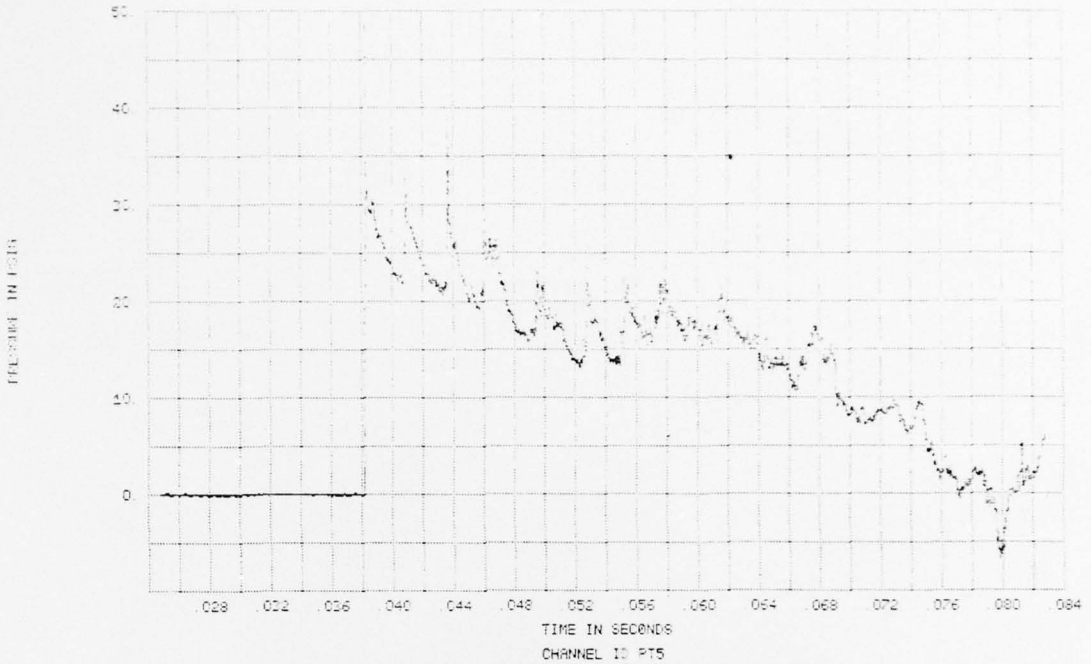


FIGURE 14-81 , SPECIMEN NO. 14-17 , SHOT NO. 7 ,
TUNNEL WALL REFLECTED PRESSURE TIME HISTORY

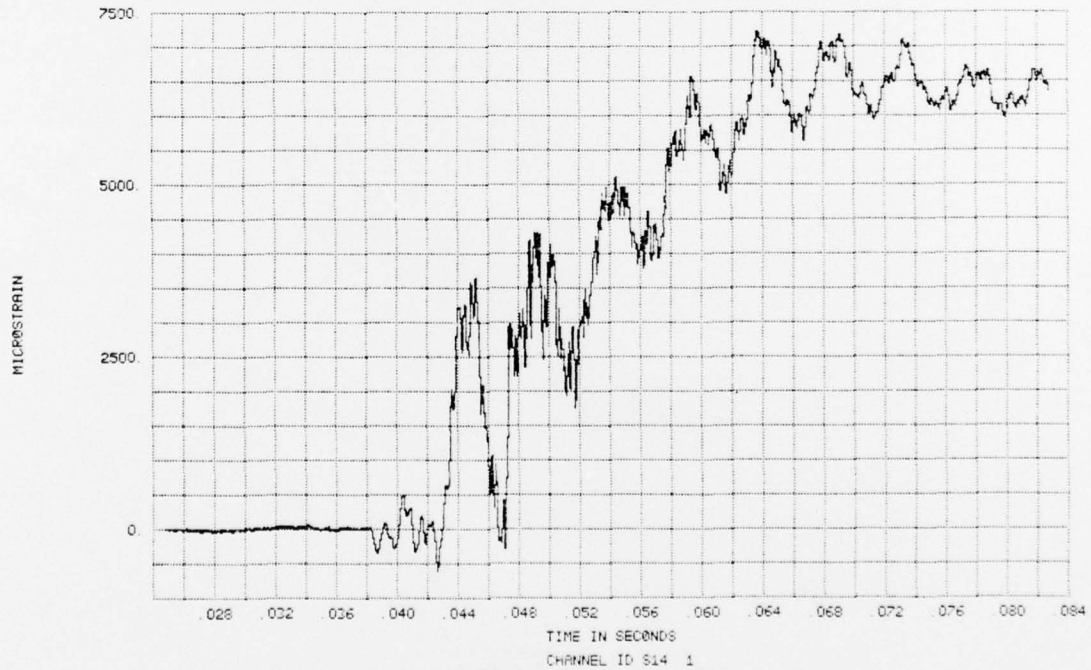


FIGURE 14-82 , SPECIMEN NO. 14 , SHOT NO. 7 .
STRAIN TIME HISTORY

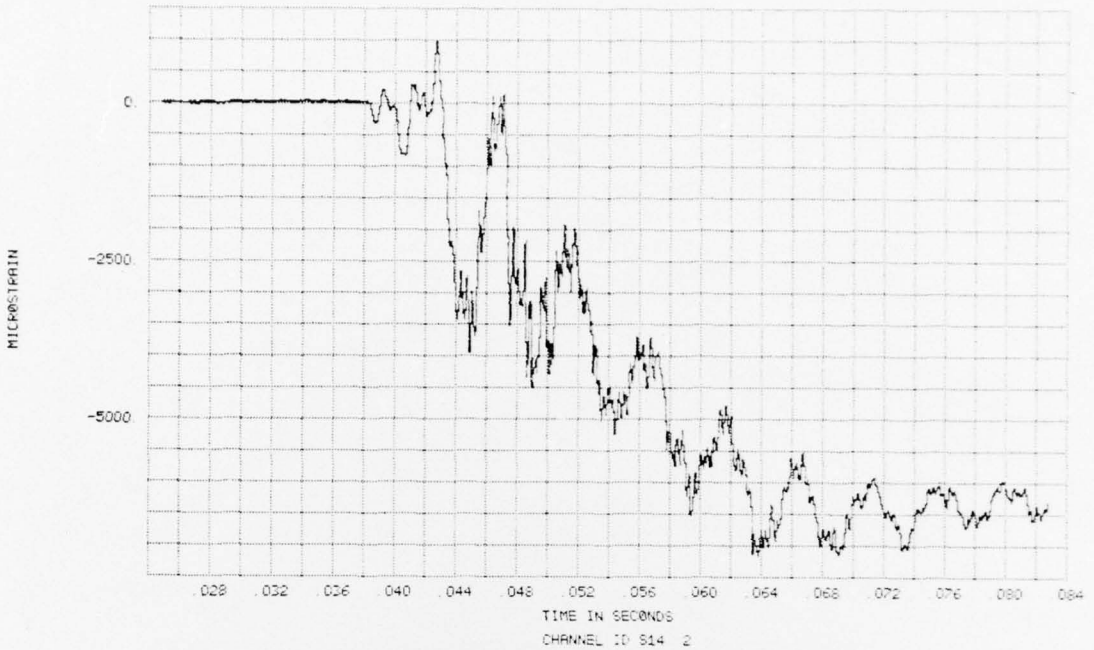


FIGURE 14-83 , SPECIMEN NO. 14 , SHOT NO. 7 , STRAIN TIME HISTORY

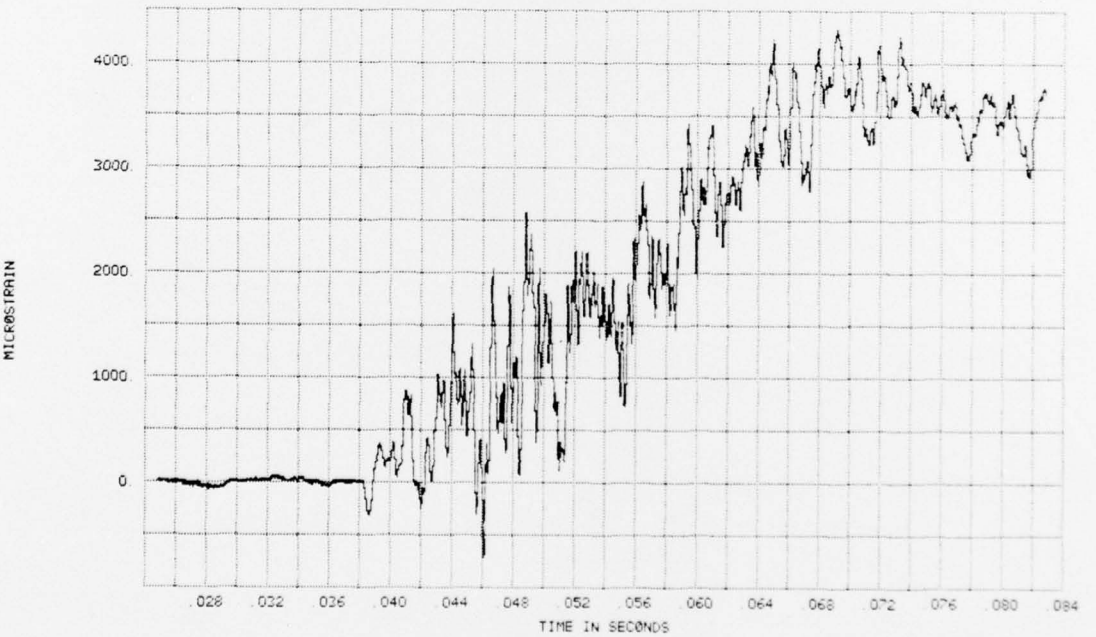


FIGURE 14-84 , SPECIMEN NO. 15 , SHOT NO. 7 , STRAIN TIME HISTORY

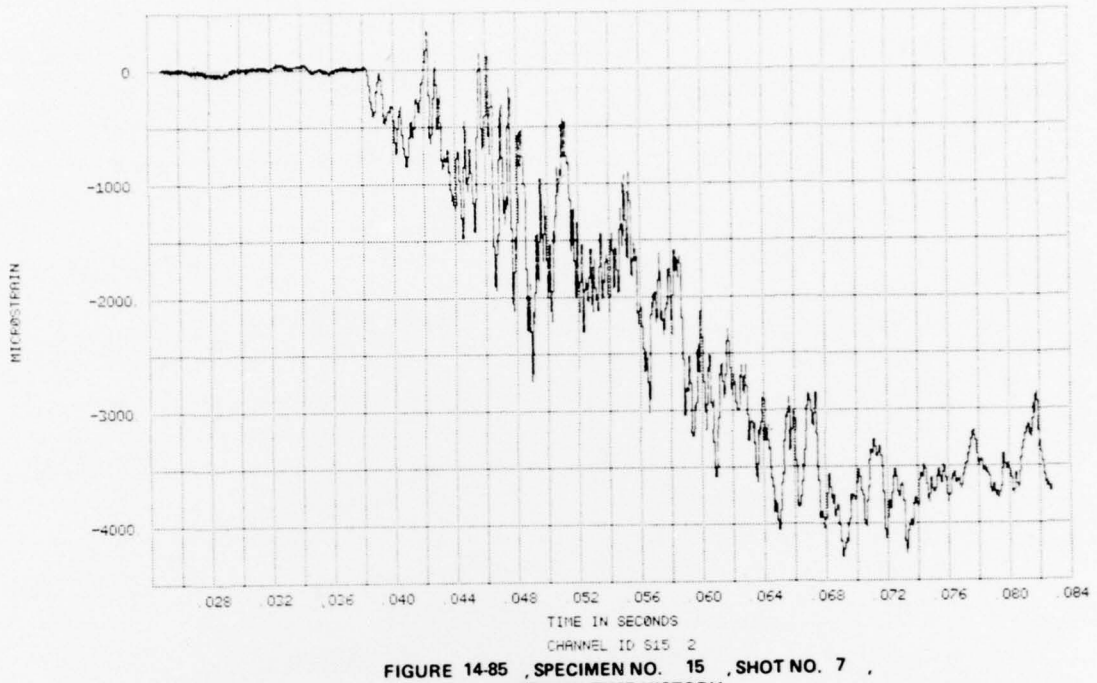


FIGURE 14-85 , SPECIMEN NO. 15 , SHOT NO. 7 ,
STRAIN TIME HISTORY

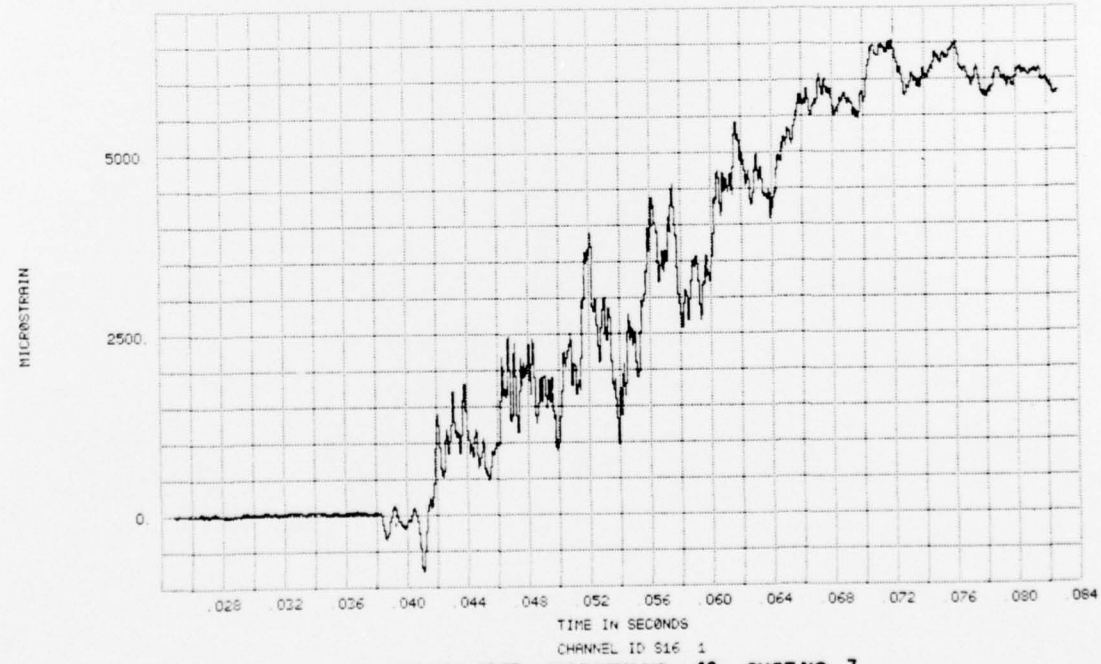


FIGURE 14-86 , SPECIMEN NO. 16 , SHOT NO. 7 ,
STRAIN TIME HISTORY

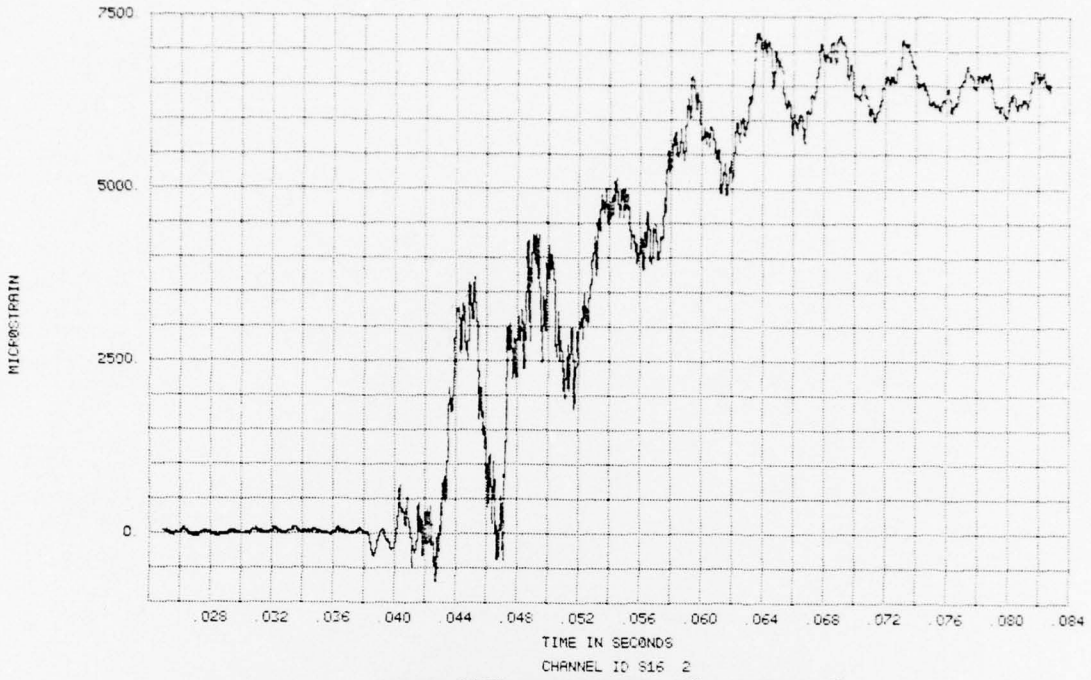


FIGURE 14-87 , SPECIMEN NO. 16 , SHOT NO. 7 ,
STRAIN TIME HISTORY

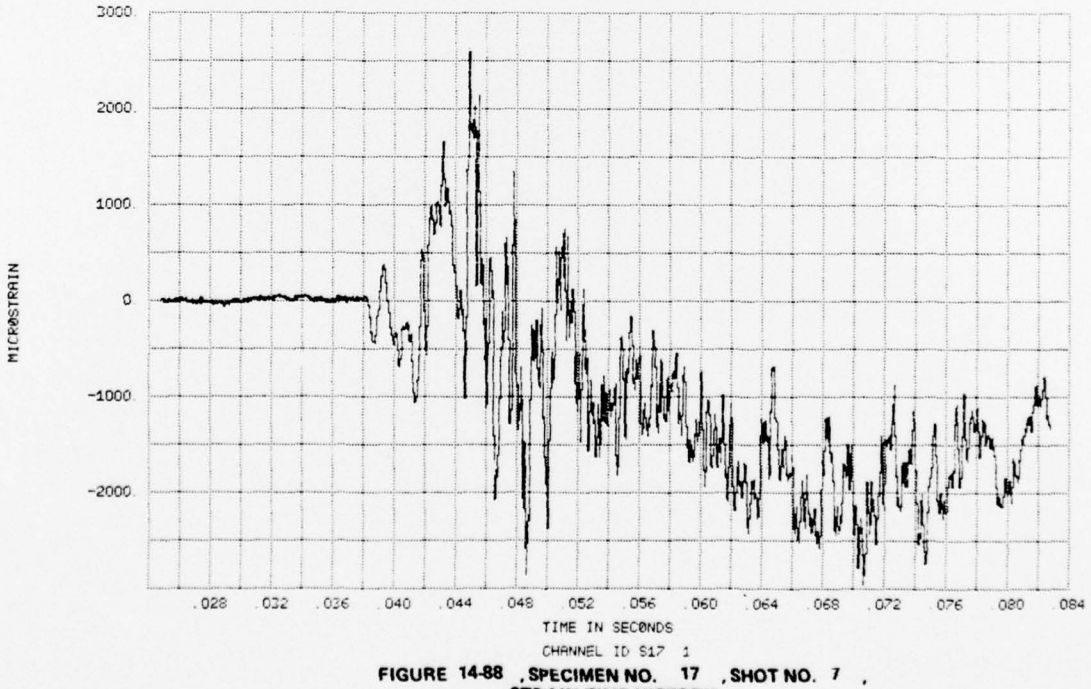


FIGURE 14-88 , SPECIMEN NO. 17 , SHOT NO. 7 ,
STRAIN TIME HISTORY

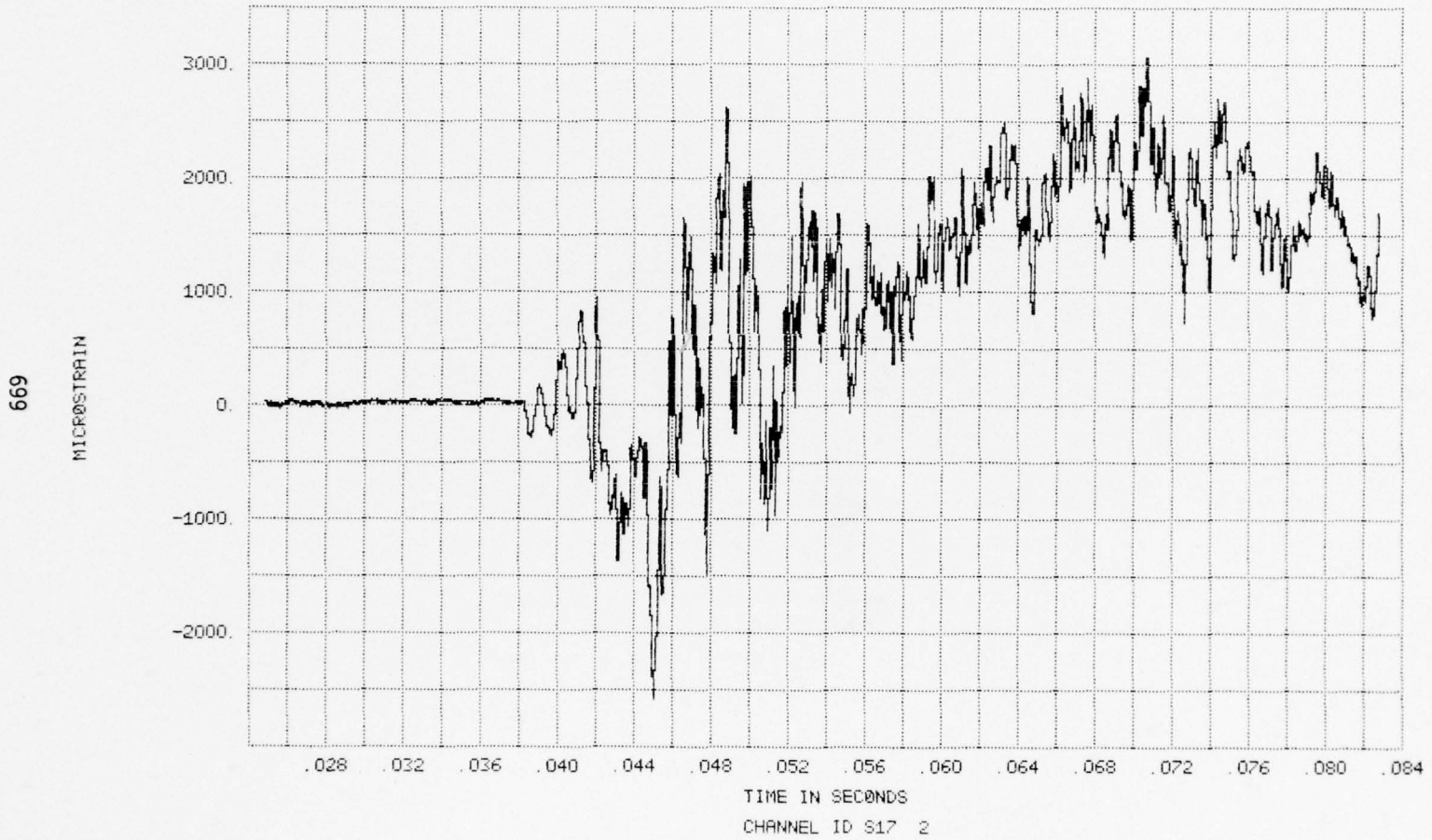


FIGURE 14-89 , SPECIMEN NO. 17 , SHOT NO. 7 ,
STRAIN TIME HISTORY

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